KSCSTE-NATPAC

ANNUAL REPORT 2016-'17

KSCSTE-NATPAC

के एस सी एस टी इ – राष्ट्रीय परिवहन योजना एवं अनुसंधान केंद्र

KSCSTE - National Transportation Planning and Research Centre

കെ എസ് സി എസ് ടി ഇ- ദേശീയ ഗതാഗത ആസൂത്രണ ഗവേഷണ കേന്ദ്രം

An Institution of Kerala State Council for Science, Technology and Envioronment
Sasthra Bhavan, Pattom - 695004, Thiruvananthapuram

ANNUAL REPORT
2016-’17

KSCSTE-NATPAC
National Transportation Planning and Research Centre
(An Institution of Kerala State Council for Science, Technology and Environment)
Sasthra Bhavan, Pattom Palace P.O, Thiruvananthapuram -695 004
www.natpac.kerala.gov.in
E-Mail:contactus.natpac@kerala.gov.in

CONTENTS

Message from the Director…

I am extremely privileged to present the Annual Report of NATPAC for the period 2016-'17. This report gives an over view of the activities of the Centre from April 2016 to March 2017. During this year, the Scientists of the Centre handled 32 R & D Projects and 21 Sponsored Studies.

As an organization dealing with traffic and transportation, we strive to contribute our best to serve the public in the most efficient and effective ways possible. In this Report we are highlighting NATPAC's achievements and activities to advance our vision 'to shape and create an efficient, effective, safe and environment friendly transportation system in the State'.

NATPAC developed a perspective plan for National Highway sections in Kozhikode on a demonstration mode. Integration of Multi Modal Transportation System (IMMTS) promotes public transport in urban areas and this concept is highlighted in our reports. A well co-ordinated integration of different modes brings about greater convenience for the commuters, efficiency and cost effectiveness.

NATPAC studied the development of feeder route services for the proposed light metro in Thiruvananthapuram City. At the instance of Town and Country Planning Department, GoK, the Centre carried out Traffic and Transportation studies for eleven towns in Kerala and prepared long term traffic and transportation improvement proposals.

To ensure mobility needs of the goods and people in a safe and sustainable manner, NATPAC prepared Comprehensive Mobility Plan for Thrissur City in Kerala. The traffic improvement measures for Medical College area in Thiruvananthapuram City was recommended by NATPAC. This will in turn tackle the traffic congestion issues and problems related to parking.

A conceptual plan for providing grade separated pedestrian facility at Cotton Hill Girls Higher Secondary School, Vazhuthacaud, Pattom – Kesavadasapuram road and East Fort area in Thiruvananthapuram was prepared by NATPAC. NATPAC evaluated the auto rickshaw operations in Thiruvananthapuram city to streamline their operations as a supplementary mode of operation to Public Transport. A concept report for improving Alappuzha city was prepared by the Centre by integrating canal and road network on a short and long term basis.

The study for the appraisal of the performance of highways developed under Kerala State Transport Project (KSTP) helps in formulating deterioration models for the State roads. A pavement design strategy for the road stretch from Ambalappuzha – Podiyadi section in Alappuzha and Nadukani – Parappanangadi road in Malappuram District was formulated by NATPAC. Rehabilitation strategy to the pavement of 22 kms long Purakkad – Pathirappally section of NH 66 in Alappuzha District was worked out by NATPAC.

A study for determining the suitability of Recycling of Asphalt Pavements in Kerala conditions was undertaken by the Centre. To promote reuse/recycling of construction waste materials, a study has been undertaken in using construction demolition waste material as a partial replacement sub base layer. The

use of waste plastic materials in geotechnical applications was also studied by NATPAC under its research schemes.

NATPAC is in the process of carrying out the feasibility study for developing the Coastal Highway from Thiruvananthapuram to Kasargode with minimum impact on the existing eco system which is under implementation. Government of Kerala requested NATPAC to prioritise the Hill Highway Sections for inclusion under Kerala Infrastructure Investment Fund Board in Kerala State.

The main priority of our Traffic Safety Division is to reduce motor vehicle and pedestrian accidents through Road Safety Education Programmes. NATPAC completed road safety transformation of three major road stretches in Gurugram, Haryana in association with Maruti Suzuki India Limited (MSIL). The impact of the installation of speed governors on the safety of heavy vehicles and their fuel efficiency was assessed by the Centre.

NATPAC carried out an investigative study to identify various factors related to seat belt usage among car occupants and evolved suitable interventions for increasing seat belt use rates. The Centre is continuously monitoring the accident scenario in Kerala by regularly undertaking on-the-spot investigation of accidents in the State and there by suggesting accident counter measures. About 80 road safety awareness programmes were carried out in the year.

Water Transport is and inexpensive, non-polluting and energy-efficient means of Transport. This will also give a boost to eco-tourism and commerce. NATPAC is in the process of assessing the accident and safety aspects related to Inland Waterways in Kerala. The Centre assessed the utilization of Waterways for navigation and put forward policy recommendations for developing Water Transport in an efficient and sustainable manner.

The Library of NATPAC is a specialized one which caters not only to the scientific community of the institute but also extends its services to the scientists and research students of various research institutions and universities.

NATPAC is providing facilities to students for their project work and training. During the year, several students from reputed academic institutions carried out their project work for B.Tech/M.Tech programmes.

The support received from the Hon'ble Chief Minister of Kerala, Hon'ble Minister for Transport, Hon'ble Minister for Health, Hon'ble Minister for Power and Hon'ble Minister for Works have been great driving force in our accomplishments. The constant support received from the Executive Vice President of KSCSTE, Research Council and Management Committee of NATPAC is gratefully acknowledged. The accomplishments over the past years and the work ahead depends on the support and contribution of our dedicated Staff. I am immensely grateful to our Staff whose energy and support sustain us. "Alone we can do so little; together we can do so much."

Thank You and I look forward to another amazing year for NATPAC.

Dr. B.G.SREEDEVI
DIRECTOR

SUMMARY OF PROJECTS

1. *Estimation of Trip Generation Rates for Different Land Uses in Kerala*

Introduction

Traffic generation studies improve estimates of traffic activity associated with land uses of particular types and magnitudes. In the case of projects generating travel demand, estimation of unit rate of traffic generated out of the proposed development is of prime importance. Determination of specific trip generation rates will help in site impact studies and regional planning studies.

NATPAC took up a study for estimating trip generation rates of different land uses in two phases corresponding to two different urban areas during the years 2016-17 and 2017-18. The study proposes to evolve out an easy-to-apply process for use by transportation professionals for estimating vehicular trip generation in built-up urban areas, incorporating the effects of site-specific, local, and area-wide land use and transportation characteristics on estimates of vehicular trip generation. This study also provides a comprehensive urban trip attraction database of different land uses. The land uses considered were work centres, official complexes, shopping centers, institutional campuses and other land use developments.

Study methodology

The methodology adopted for the study consisted of reconnaissance survey, selection of proxy survey sites in the study area based on specific land use, surveys and data collection and traveler intercept surveys. Trip rate analysis method is used in the study for working out the trip generation rates per unit area of land use.

Interim Study outcome

The trip generation rates of various land uses or activity centres (trip rates/unit) which could be further used for transportation impact analysis and for long range forecasting, community level planning and in corridor studies are estimated based on the analysis of studies conducted. The most applicable outcome of this study is the production of quantitative information on travel characteristics of urban land uses like shopping centers, which can be used in traffic impact studies. Trip generation rate estimated for different land uses in terms of peak hour person and vehicle trip rates are given in **Table 1.**

Table 1: Summary of Peak hour trip rates for different land uses

Sl. No.	Name of land use	Type of land use	Peak hour trip rate		
			person	Vehicle	Vehicle
1	Kinfra International Apparel Park, Thumba	Industrial	5.89	0.78	trips/1000sq.ft./hr
2	Kedaram shopping complex	Commercial centres	6.11	1.22	trips/1000sq.ft./hr
3	Pothys Trivandrum		4.7	1.187	trips/100sq.ft./hr
4	Connemara market		1.41	0.247	trips/100sq.ft./hr
5	Big Bazaar		3.16	1.26	trips/1000sq.ft./hr
6	Saphalyam Shopping Complex		0.4	0.076	trips/100sq.ft./hr
7	Kairali / Sree / Nila theatre	Recreational centres	1.83/seat/hr	0.16/sq.ft/hr	
8	Al-Saj Convention Centre, Kazhakkoottam		1.58	2.54	trips/1000 Sq. ft./hr
9	Napier Museum		0.12	0.003	trips/100sq.ft./hr
10	Kanakakkunnu Palace		3.05	0.6	trips/100sq.ft./hr
11	Palayam Juma Mosque, Thiruvananthapuram	Religious places	2.38	-	trips/10 sq.ft./hr
12	St. Joseph's Cathedral, Palayam		27.51	10	trips/1000sq.ft./hr
13	O.T.C Sree Hanuman Swamy Temple, PMG Junction		7.85	1.79	trips/1000sq.ft./hr
14	Pazhavangadi Ganapathy Temple, East fort		2.15	0.5	trips/10sq.ft./hr
15	Lourdes Forane Church, Trivandrum		1.2	0.3	trips/100sq.ft./hr
16	Thiruvananthapuram General Post Office	Public Services	5.38	1.33	trips/1000sq.ft./hr
17	Thiruvananthapuram Municipal Corporation	Work centre	50.73	17.8	trips/1000sq.ft./hr
18	Public office Complex, Thiruvananthapuram		0.83	0.415	trips/100sq.ft./hr
19	Life Insurance Corporation, Pattom		0.3	0.15	trips/100sq.ft./hr
20	Al-Saj Restaurant, Kazhakkoottam	Retail shopping centres/Hotels	2.5	0.81	trips/100 sq.ft./hr
21	Bhima Jewelers, Trivandrum		16.63	3.27	trips/1000sq.ft./hr
22	Zam Zam Restaurant, Palayam		1.22	0.33	trips/100sq.ft./hr
23	Credence Hospital, Trivandrum	Medical	3.5	1.63	trips/1000sq.ft./hr
24	General Hospital		5.6	1.81	trips/1000sq.ft./hr
25	State Central Library Thiruvananthapuram	Institutional	6.97	2.39	trips/1000sq.ft./hr

Status of the study

Study pertaining to phase 1 namely Thiruvananthapuram city has been completed during the year 2016-17. In the year 2017-18, new urban areas will be identified for detailed study. Based on both phases of study, final report will be prepared.

2. Strategic Plan for the Development of National Highway Network in Kerala – Kozhikode Division

Introduction

As part of the Plan Program for the year 2016-17, NATPAC developed a Perspective Plan for National Highway sections in Kozhikode division on a demonstration mode. The sections included the following;

- NH 66 from Idimoozhikkal to Poozhithala (75.30 km) including the bypass section from Nisary junction to Vengalam and
- NH 766 from West Hill to Wayanad District border near Vythiri (53.30 km).

Methodology

The methodology adopted for the study composed of the following series of tasks:

- Detailed inventory of the study corridors;
- Undertaking of traffic volume studies and estimation of present link volume, intersection volume and anticipated traffic;
- Conduct of speed and delay studies along the various corridors to identify the stream speed and average delay along the corridors;
- Conduct of pedestrian movement survey;
- Preparation of baseline report for the study area;
- Identification of specific interventions in the form of intersection improvements, necessity of grade separators, bypasses, pedestrian grade separators etc. for the study stretch;
- Quantification of benefits accrued due to the various suggested interventions like savings in travel time, pollution cost and fuel cost;
- Economic analysis to determine the Benefit-cost analysis of the suggested interventions.

Results and Discussions

The following outputs emanated from the study.

- The link volume ranges between 17,500 and 40,000 PCU on NH 66 and between 13,000 and 33,500 PCU on NH 766;
- The Volume to Capacity ratio is found to be much above one for both the existing and projected traffic cases;
- Along the study corridor, Thondayad Junction witnessed the maximum peak hour traffic flow of 6,299 PCU followed by Malaparamba Junction with 4,818 PCU;
- At the locations where pedestrian movement is prevalent, the value of pedestrian-vehicles conflicts (PV2 value) varied from 7.2 x 108 to 42 x 108 warranting construction of grade separated facilities;
- Stream speed along the study corridors decrease to 35.5 kmph from the average free flow speed of 72.4 kmph;
- A development plan has been envisioned for the study stretches which consisted of;
  - Construction of paved shoulders by the year 2017
  - Upgrading of the section to four lanes and construction of grade separators at major intersections by the year 2020
- Cost – Benefit analysis for the suggested development options indicates high value of 1.57 for NH 66 corridor and 1.30 for NH 766 corridor;
- In a nutshell, the improvements worth Rs.3,313 crores yield savings of Rs.4,476 crores towards fuel charges, time saving and pollution saving in addition to reduction in accident costs.

3. Development of Traffic Growth Rate Model for National Highways in Kerala

Introduction

As the rapid growth in the national economy boost the transportation demands, the importance of traffic demand prediction has significantly increased. This in turn helps for providing proper engineering design, evaluation of the economic and financial viability of transport facilities and planning. Accordingly, NATPAC is developing a traffic growth rate model for the National Highways in Kerala as part of the centre's research study.

Methodology

The methodology adopted for the study consisted of establishment of volume count stations, establishing relationships between the collected data and socio economic indicators and

development of a suitable model for traffic growth rate using statistical techniques. Traffic projection should reflect expected economic, demographic and land use trends based on historic and projected relationships between the factors and regional traffic growth.

Interim study outcome

Three locations situated in southern Kerala, central Kerala and northern Kerala on National Highway – 66 were selected for the primary data collection and two sets of 7 days, 24 hour classified traffic volume data were collected from each of these locations. The following three locations were selected for the data collection;

(i) Kalluvathukkal in NH 47 (NH- 66) at Kollam district,
(ii) Paliyekkara in NH 47(NH 544) at Thrissur District and
(iii) Kunjippally near Vadakara in NH 17(NH 66) at Kozhikode district.

Classified Volume count was obtained in all the three locations. It is being observed that the number of vehicles plying in Kalluvathukkal in NH 47 (NH- 66) at Kollam district was 31,715 PCU in July 2016 and 35,221 PCU in March 2017, 68,189 PCU was observed in Paliyekkara in NH 47, (NH 544) at Thrissur District in the month of February 2017. In Kunjippally near Vadakara in NH 17, (NH 66) at Kozhikode district 31,990 PCU was observed in October 2016.

Status of study

As the study is of five years duration, it is proposed to establish three permanent volume count stations in the State during the study period. The data collected will be utilized and correlated with various socio-economic indicators to arrive at a traffic growth rate model applicable to NHs.

4. Integration of Multi-Modal Transit System for Urban Areas: A Case Study of Cochin City

Introduction

Integration of Multi Modal Transportation System (IMMTS) explores the co-ordinated use of two or more modes of transport for speedy, safe, pleasant and comfortable movement of passengers in urban areas. The major goal of IMMTS is to promote public transport in urban areas. The objectives of the study were:

- To review the various components of integrating the Multi-model transport system

- Identify various multi model services such as Metro, Public Transport, ferries, non-motorised transport such as bicycles including including para transit in the form of autos
- To identify mechanism for physical infrastructure integration
- To develop fare integration for various multi-model services

The scope of the study was limited to three major proposed metro stations: Vyttila, Edappally and Kaloor in Kochi City. These three stations were selected as there was mass movement of people across the influence zone of these three stations when compared to the others.

Methodology

A detailed literature survey was conducted to investigate the various studies conducted on the integration of multi modal systems in various cities. Surveys conducted include road inventory, bus passenger interview as well as stated preference survey. Secondary data collected included the data collected from the reports submitted by NATPAC such as Comprehensive Mobility Plan, Detailed project report of Kochi metro and Transit Oriented Development Plan .The collected data were analysed and recommendations were framed.

The public transport passenger analysis helped in evaluating bus demand in each time interval. It also gave the peak number of commuters boarding and alighting at each of the stations and also aided in arriving at the peak hour of demand of buses. The Stated Preference survey identified the travel patterns and preference of the interviewed respondent. Separate questionnaires for the bus users and the other mode users (Car, 2 Wheeler & Auto) were prepared. The last section on both the questionnaires was supported by three scenarios for each mode. It was intended to provide the respondent with varying scenarios with existing and proposed system attributes such as travel time, waiting time, fare/cost and comfort level. The commuters were asked questions covering respondent's existing travel pattern and socio-economic characteristics. It also collected information regarding the perception of the existing public transport system in the study area.

Table 2 Attributes of Different Scenarios

Attributes	**Scenario 1(SC1)**	**Scenario 2(SC2)**	**Scenario 3(SC3)**
Waiting Time	Reduced by 25%	Reduced by 25%	Reduced by 10%
Travel time	Same as existing	Reduced by 25%	Reduced by 25%
Travel cost	Increased by 25%	Increased by 25%	Increased by 50%
Transfers	Yes	No	No
Comfort Level	Sitting+standing+Non AC	Sitting + NonAC	Sitting + AC
Access/Egress Time	Same as existing	Reduced by 25%	Reduced by 25%

A model was developed using N Logit software to predict the willingness of the commuters to shift to a scenario different from the existing conditions of travel time, travel cost as well as waiting time. NLOGIT is an extension of another very large, integrated econometrics package, LIMDEP is used world-wide by analysts of models for regression, discrete choice, sample selection, censored data, count data, models for panel data, etc. The following utility equations were developed using NLOGIT

U(SC1)=9.33821SC1+0.00203*TT-0.10296*WT+0.81386*AGE

U(SC2)=3.57351+0.00203*TT-0.10296*WT +2.23968*MI

U(SC3)=0.00203*TT-0.10296*WT +2.90859*MI

Where, U (SC1) = utility value of Scenario 1

U (SC2) = utility value of Scenario 2

U (SC3) = utility value of Scenario 3

TT: Travel time

WT: Waiting Time

AGE: Age of the commuter

MI : Monthly Income of the commuter

By analysing the multinomial logit model, it is found that the choice of the scenario mainly depends on the age and monthly income of the commuters All the coefficients of variable used in the model had logically correct signs and acceptable significance. The model also had an acceptable pseudo R^2 value.

Summary and conclusions

The existing transport system of Kochi city was analysed as part of the study. Results of bus passenger interview survey indicated that bus was the predominant mode of travel from origin to boarding point while walking was the predominant mode from alighting point to destination of the bus users. It was found that majority of the commuters from the three study areas travel with work as the major trip purpose. By analysing the N Logit Model developed, it was found that the choice of the scenario mainly depends on the age and monthly income of the commuters. Significant integration strategies have been recommended as a part of the study involving both fare integration involving hand held ticketing devices and smart cards as well as physical integration strategies involving walking and cycling. It was also recommended that ITS could be used to provide user information, monitor system operations, compliance to schedules and service quality, minimize revenue leakages, reduce costs and enhance safety.

5. Consultancy Services for Light Rail Transit in Thiruvananthapuram

Background

Government of Kerala (GoK) is in the process of implementing a mass transit system in Thiruvananthapuram City, in the form of a Light Metro Rail (LMR) connecting Technocity near Pallipuram to Karamana covering an approximate distance of 22 km. Proposed in three reaches, Reach 1 (R1) is from Technocity to Kazhakkoottam (5.560 km), Reach 2 (R2) is from Kazhakkoottam to Kesavadasapuram with a length of 9.375 km and Reach 3 (R3) is from Kesavadasapuram to Karamana (8.024 km). To ensure the smooth flow of traffic along the NH 66, flyovers are proposed at four intersections at Sreekaryam, Ulloor, Pattom and Thampanoor. Delhi Metro Rail Corporation Ltd (DMRC), has been entrusted with the preparation of the preparation of Detailed Project Report for the LMR. DMRC in turn requested NATPAC to prepare the land acquisition plan of the LMR route and the stations.

Tasks carried out

The following tasks were accomplished by NATPAC:

- Conduct of topographic survey and preparation of base map of Reach 3;
- Integrating newly prepared map of Reach 3 with available topo maps of Reaches 1 and 2 and to make a single drawing of the whole project;
- Preparation of land acquisition (LA) plan for all LMR stations;

- Preparation of LA plan for proposed alignment where road widening is required;
- Preparation of LA plan for flyovers at Sreekaryam, Ulloor, Pattom and Thampanoor.

Study outcome

Based on topographic survey and data given by DMRC, the base map was prepared. The drawings submitted includes the Centre line of proposed Right-of-way (ROW), existing ROW, edge of black topping, details of drains, details within the corridor, land acquisition plan for all LMR stations, land acquisition details for road widening from Pallippuram to Kesavadasapuram and from Thampanoor to Killipalam, land acquisition plan for flyovers at Sreekaryam, Ulloor, Pattom and Thampanoor, and utility plan for water line, sewer line and BSNL line from Pallippuram to Karamana. Land Acquisition plan and utility plan were prepared based on the details given by the DMRC.

6. Development of Feeder Route Services for Proposed Light Metro System in Thiruvananthapuram City

Introduction

Development of Feeder Routes is an important aspect of operational integration of Public Transport mode. NATPAC undertook a study on development of feeder route services for the proposed light metro in Thiruvananthapuram City as part of the centre's Plan program for the year 2016-17. The objectives of the study were:

- To identify various feeder routes based on the passenger demand from potential destinations;
- To estimate shortest route using GIS algorithm;
- To identify various types of feeder service such as Bus, mini bus, Non-motorized transport (NMT) etc.;
- To develop feeder service schedule integrated with LRT system;
- To prepare various intelligent transportation systems (ITS) and integration strategies.

Methodology adopted for the study

The methodology adopted for the study consisted of collection of relevant data through primary and secondary sources and analyzing the data through statistical software and estimating demand for feeder routes services. Primary surveys conducted included public

transport surveys, bus passenger opinion surveys and road inventory. Secondary data was collected from 20 KSRTC Depots to understand existing public transport service characteristics, which included number of buses in each route, schedule of buses, route length etc. The collected data was processed and existing public transport route network was developed in Geographical Information System (GIS) platform. Then potential traffic generating nodes that come within 6 km buffer area of the metro corridor were identified. Passenger demand from these identified potential nodes were estimated and possible feeder routes connecting the proposed metro stations and the identified potential traffic generating nodes were identified and from the identified routes, optimization was done based on the selected set of criteria.

Study outcome

For the seven LRT stations coming within the scope of the study, 18 feeder routes were proposed, which are classified as point to point routes (17 routes) and circular routes (1 route). Schedule was prepared by keeping the service frequency of feeder services in synchronization with metro frequency. After fixing the operational characteristics and vehicle type for the feeder bus service, time schedule for the proposed feeder system integrated with the LRT system was developed. As the Metro would be operating for 18 hours between 5 am and 11 pm, the feeder services were planned for similar period. Load factor was varying between 0.48 and 0.96, and headway was varying between 4 and 16 min, during peak and off-peak periods. To meet the motive of Thiruvananthapuram Metro of reducing carbon emissions through sustainable public transport, environment friendly vehicles such as electric/hybrid vehicles or CNG vehicles were proposed for the system. **Figure 1** shows the proposed feeder routes.

Figure 1: Proposed Feeder Routes

The feeder routes were generated by minimizing the travel time subject to unsatisfied passenger demand constraint. This lead to an optimal feeder route configuration, with the routes being demand oriented as well as following the shortest possible path of the commuters. The feeder routes would thus contribute to the achievement of the forecasted ridership on the LRT system, and would also allow the commuter to travel through the shortest possible path from his origin to final destination via the developed integrated mass transit network. ITS technologies would help transit agencies to automate operational characteristics like scheduling and compliances, revenue management, commuter interfaces like route information and real time control on almost all activities.

7. Traffic and Transportation Studies for 11 Towns in Kerala State

Background

At the instance of Town and Country Planning Department, Government of Kerala, Traffic and Transportation Studies for the following 11 towns in Kerala were carried out by NATPAC.

No.	Town	District
1	Kottarakkara	Kollam
2	Harippad	Alappuzha
3	Erattupetta	Kottayam
4	Kattappana	Idukki
5	Koothattukkulam	Ernakulam
6	Piravam	
7	Guruvayoor	Thrissur
8	Vadakkancherry	
9	Pattambi	Palakkad
10	Mananthawady	Wayanad
11	Kannur	Kannur

The following were the major objectives of the study.

- Assess the existing road network and to identify the traffic bottlenecks;
- Study the traffic volume on selected roads and to assess the extent of shortfall of the road system;
- Study the Origin-Destination characteristics of traffic passing through the town;
- Assess the traffic flow pattern for the horizon year and formulate a road development plan for the town.

Preparation of detailed engineering/structural design of the improvement proposals was not the part of this study.

Methodology adopted for the Study

The methodology adopted for the study consisted of reconnaissance survey, review of past study reports, collection of secondary data, conducting primary surveys, analysis of data, estimation of traffic and transport demand for horizon years and identification of deficiencies in road network and major travel corridors and preparation of long term traffic and transportation improvement proposals.

Transport development plan for the towns were prepared taking into account the existing traffic scenario and based on an evaluation of the future traffic on the base year network. Transport development schemes covered all the available modes of travel and are formulated so as to reduce the severe strain put on the existing road network. All committed development schemes were taken into account while formulating the transport development plan. The planning approaches have short term, medium and long term proposals.

Town wise study outcome

1. <u>Wadakkanchery Town</u>

Wadakkanchery Municipality is spread over an area of 51.33 sq.km with a population of 61,431 in 2011.

Speed and delay characteristics: The average journey speed was highest on SH 76 where no delay was encountered. Slow average running speed of below 30 kmph was observed on Karumathra road, Medical College – Athani road, Medical College – Mundathikode road and Athani - Thiruthiparambu road. On other roads in the study area, relatively higher levels of speed were observed.

Capacity utilization of major roads: Most of the roads had volumes much lesser than their capacity except for SH 22 which is the central road running through the town.

Parking: Mini civil station section of SH-22 had the highest peak parking accumulation of 164 ECS on the right side, followed by Athani market area with 105 ECS on the right side of the road. Other location with heavy parking accumulation was found to be Ottupara bus stand area. Most of the vehicles parked on the roads were found to be two wheelers followed by cars.

Inter-city passenger traffic: A total of 46,638 inter-city passenger trips were performed in the study region on a reference day consisting of 63.11% bus passenger trips, 20% car trips, 12.26% auto-rickshaw trips and 4.8% two-wheeler trips. This includes 43% of External – External trips.

Inter-city goods transportation: 5,857 goods vehicles were found to be carrying goods to and from the study area with a quantum of 8,133 tonnes. Mini Trucks carried the maximum tonnage of goods (48.45%), followed by Trucks (43.82%).

Traffic projection: All the major road corridors within the central area of the town would be congested in the horizon year with the anticipated traffic more than the capacity of the roads under "do-nothing option".

Proposed Transport Development Plan

Since the most important problem of Wadakkanchery town is the traffic congestion at the central part of the town due to inadequacy of road width and conflicting movements of traffic at the major intersections, the development strategy addressed the issues of traffic congestion comprehensively and adopt adequate capacity augmentation schemes so that frequent and regular traffic hold-ups are minimized. Importance was given to increase the capacity of major intersections by proper planning and design. Special emphasis was there to develop off-street parking lots and also to provide adequate pedestrian facilities in the central business area of the town. Integration of different modes of transport will fetch immediate returns in efficient utilization of public transport services and will bring increased patronage, thus reducing the incidence of personal vehicles.

2. Guruvayoor Town

Guruvayoor Municipality is spread over an area of 29.66 sq km with a total population of 1,48,383 persons comprising of 20,483 families.

Speed and delay characteristics: The average journey speed of travel in Guruvayoor was 33 kmph with an average delay of 4.4 percent of the total travel time. The journey speed on various roads in the study area varied between 18 and 49 kmph. The State Highways leading out of the town were observed to have an average journey speed of 39.3 kmph while that on Inner Ring road and Outer Ring road were observed to be 22.5 kmph.

Capacity utilization of major roads: The roads like SH 50, Outer Ring road and SH 49 were found to be over utilized as their volume surpasses their capacity. Some road stretches like Guruvayoor - Karakkad road and Chowallurpadi-Pavaratty road were nearing their capacity while all other roads have Volume Capacity (V/C) ratio below 0.80.

Parking: Venugopal parking off Inner ring road (IRR) had the highest peak hour parking accumulation of 494 ECS followed by Railway station with 414 ECS. Other locations with heavy parking were found to be the parking areas near South Nada and Ambady parking off IRR. Other locations have ECS value below 100. Major share of parked vehicles were found to be car followed by two wheelers, tempo and bus.

Inter-city passenger traffic: An estimated 4.84 lakhs inter-city passenger trips were performed in the study region on a reference day. About 43% of trips were found to be External – External trips.

Inter-city goods transportation: A total of 14,127 goods vehicles were found to be involved in carrying goods traffic to and from the study region with a quantum of 14,412 tonnes. Trucks carried the maximum volume of goods traffic constituting 59%, followed by mini-trucks with 25%. The remaining 16% of goods traffic was handled by goods autos.

Inter-city vehicular movements: An estimated 49,518 PCU of vehicles passed through Guruvayoor, out of which bulk movements were between Thrissur and Chavakkad followed by between Chavakkad and Pavaratty.

Traffic projection: All the major road corridors within the central area of the town would be congested in the horizon year with the anticipated traffic more than the capacity of the roads under "do-nothing option".

Proposed Transport Development Plan

Similar to the other towns, traffic congestion is the most important problem for the central part of Guruvayoor town. Here also the insufficient width of road and conflicting movements of traffic at the major intersections are the key factors to be tackled. The development strategy addressed the issues of traffic congestion comprehensively and adopted adequate capacity augmentation schemes, so that the issues related with the smooth flow of traffic are reduced.

The development proposals gave importance to increase the capacity of major intersections by proper planning and design. Special emphasis was given to develop off-street parking lots (Multi Level Car parking complex) and also to provide adequate pedestrian facilities.

The development strategy also aimed to utilize the application of Intelligent Transport system for enhancing the traffic flow management and reducing traffic offences and accidents.

3. Koothattukkulam Town

Koothattukkulam Municipality has an area of 23.18sq.km with a population of 17,253 as per census 2011. Population density of the village is 746 persons per km^2. A stretch of 4.7km of Main Central (MC) road passes through Koothattukkulam town and it connects the town with Moovattupuzha on the north and Kottayam on the south.

Traffic volume at major intersections: The maximum peak hour traffic flow was observed at Central junction with 2,329 PCU. It was followed by Hospital junction (1,897 PCU), Ramapuram Kavala (1,762 PCU), and Onamkunnu Temple Junction (1,741 PCU), other intersections handled traffic flow less than 1,000 PCU only.

Parking: Most of the parking was found to be in the stretch of MC Road from Central Jn to Hospital Jn with 300 vehicles, followed by 218 vehicles at Ramapuram Kavala – Central junction stretch of MC Road. Parking in Private bus stand- Central Jn stretch was also high due to it close proximity to market.

Inter-city passenger traffic: In Koothattukkulam town, the inter-city passenger transport was mainly through road based transportation. About 27,600 inter-city vehicle trips were performed in the study region on a reference day.

Inter-city goods transportation: An estimated 3,508 inter -city vehicle trips were performed by goods traffic in Koothattukkulam town with a quantum of 8,813MT.

Traffic projection: Projection of traffic on major roads has been carried out for the horizon years – 2026 and 2036, considering the growth potential of the study area so as to assess the future transport.

Proposed Transport Development Plan:

A hierarchical system of road network in ring and radial pattern is suggested for Koothattukkulam town **(Figure 2)**. With MC road as central axis, 14 radial roads are proposed for Koothattukkulam. Two ring roads – one inner ring road and one outer ring road has been proposed in the study area to avoid the dependency on one or two important corridors. As the major traffic problem is the over utilization of MC Road, a bypass is proposed for MC road in Koothattukkulam. Two alignment options have been proposed for the bypass and the final selection is to be made after detailed alignment study.

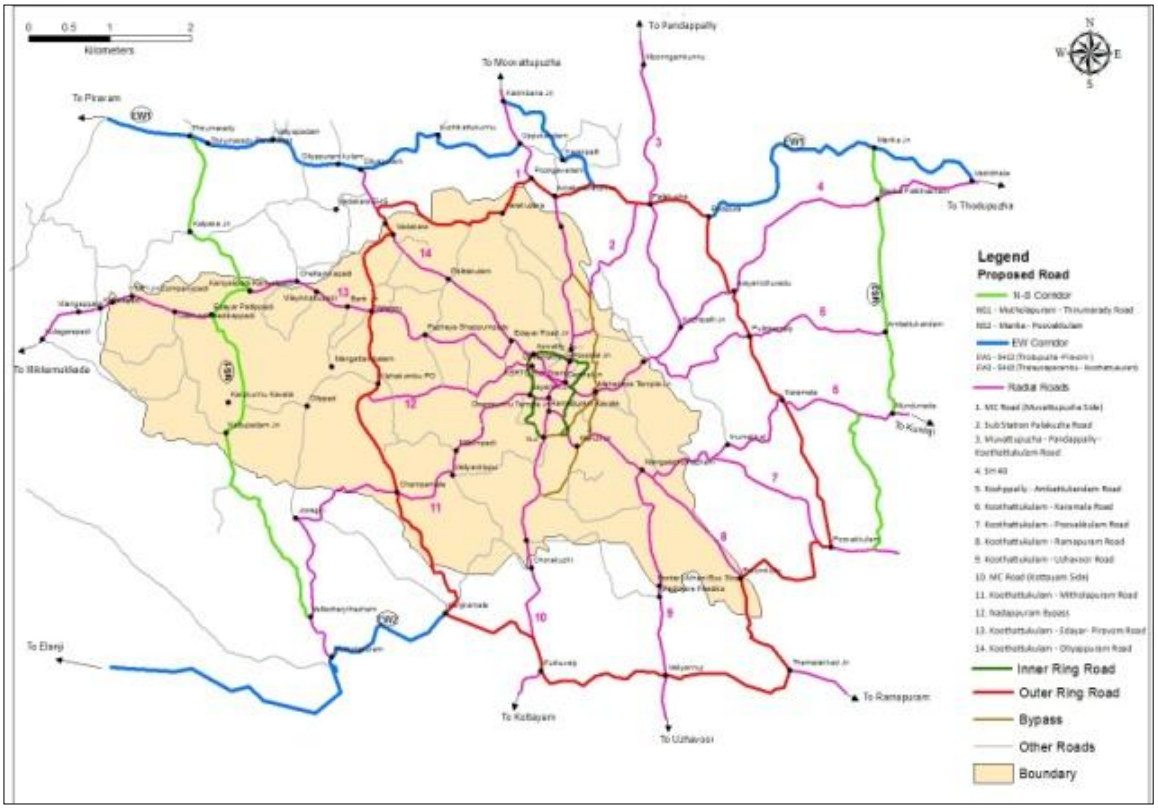


Figure 2: Proposed road network plan for Koothattukkulam town

Based on capacity utilization of road stretches reflected through volume capacity ratio, road widening proposals have been formulated for the town as shown in **Figure 3**.

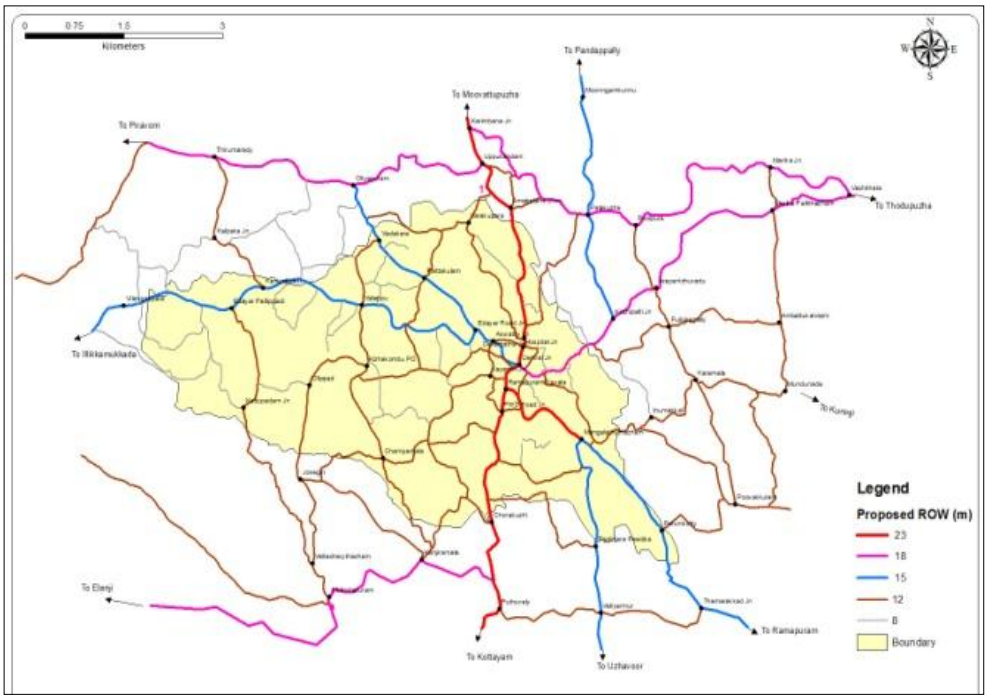


Figure 3: Road widening proposal for Koothattukkulam town

Conceptual Junction improvement proposals have been recommended for two major junctions within the Central Business District area viz. Ramapuram Kavala and Central Jn, to ensure the smooth flow of traffic through the junctions. Off-street parking lots on vacant plots have been identified to regulate on street parking on congested roads in CBD area. At-grade pedestrian crossing facilities in the form of zebra crossings have been proposed at all junctions to ensure the safe crossing of pedestrians. It is also recommended to provide footpaths with a minimum width of 1.8m on either side of the road stretches in the study area for the safe movement of pedestrians. Grade separated pedestrian crossing facilities are proposed at two locations on the stretch of MC road falling in CBD area.

Other proposals such as provision of bus stop with proper bus bay and bus shelter, up-gradation of the existing private bus stand etc. have also been made.

4. Piravom Town

Piravom Municipality has a geographical area of 29.36sqkm with a population of 27,229 and population density of 927 persons per square kilometer as per 2011 census. The PWD roads in Piravom consist of State Highways (SH), Major District Roads (MDR) and Other District Roads (ODR). Kumarakom – Cumbammettu – Cumbam State Highway (SH 42) pass through Piravom Town and connects Piravom with Elanji in the south and Moovattupuzha and Koothattukkulam in the east. Major district roads that connect various settlements within

Piravom municipality and adjoining areas are Piravom (Mullurpadi) – Kottappuram-Kalamboor Kavu Road and Maneed- Nechoor Palam- Kakkad- Onakkoor Road.

Traffic volume at major intersections: Intersections on Thripunithura- Piravom road has comparatively higher peak hour traffic volume with Post office junction handling 1,376 PCU/hr followed by Devipadi Junction (1,358 PCU/hr) and Valiyappli Kurishu (1,114 PCU/hr) and Peak hour traffic recorded at other intersection were below 1,000 PCU/ hr.

Parking: Parking of vehicles was found to be quite high in the road stretch of 500 m length from Post Office Junction to Devipadi Junction with 85 vehicles, followed by 62 vehicles at Hospital junction – New Bazaar junction road of length 500m.

Pedestrian vehicle conflicts: Central area of Piravom town such as Fathima Matha School, Post office Junction and Bus stand Junction have high pedestrian vehicle conflicts which warrants suitable interferences.

Inter-city passenger traffic: An estimated 33,445 inter-city vehicle trips were performed in the study region on a reference day consisting of 31% car, van, jeep trips, 11% auto rickshaw trips, and 58% two wheeler trips (58%).

Inter-city goods transportation: An estimated 2,647 inter -city vehicle trips were performed by goods traffic in Piravom town with a quantum of 5,786 MT.

Traffic projection: Projection of traffic on major roads has been carried out for the horizon years – 2026 and 2036, considering the growth potential of the study area so as to assess the future transport requirements. All the major road corridors within the central area of the town would be severely congested in the horizon year with the anticipated traffic more than the capacity of the roads under "do-nothing option".

Proposed Transport Development Plan:

A hierarchical system of road network system in ring and radial pattern is suggested for Piravom town. 12 radial roads are proposed for Piravom. Three ring roads –one inner ring road, one middle and one outer ring road - have been proposed in the study area to avoid the dependency on one or two important corridors. The road widening proposal is based on projected v/c ratio and its functional classification.

Conceptual junction improvement proposals have been recommended for three major junctions within the CBD area viz. Hospital Junction, KSRTC Junction and Valiyapalli Junction, to ensure smooth flow of traffic. Road alignment corrective measures are also suggested for the accident prone locations in the municipal limits. Off-street parking lots on vacant plots have been identified to regulate on street parking on congested roads in Central Business District (CBD) area. At-grade pedestrian crossing facilities in the form of zebra crossings have been proposed at all junctions to ensure the safe crossing of pedestrians.

5. Kattappana Town

Kattappana town is located 25km from Painavu, the district head quarter. Other nearest towns are Nedumkandam (25km), Cumbam in Tamil Nadu (30km), Kumali (30km), Pala (77km) and Thodupuzha (90 km). Kattappana Municipality spreads over an area of 57.65 km^2.

Traffic volume at major intersections: Idukki Kavala recorded the highest peak hour traffic volume of 2,822 PCU, followed by 2,400 PCU at Central Junction, HMTA Junction with 2,350 PCU and Vellayamkudi Junction with 2,000 PCU. Six junctions had peak hour traffic volume between 1,000 and 2,000 PCU.

Parking: Idukki Kavala to Vellayamkudi arm (300m) had the maximum parking accumulation of 70 vehicles, followed by Idukki Kavala to ITI arm for a length of 500m with 69 vehicles, Central Junction to Chennattumuttam-HMTA road stretch with 64 vehicles and Central Junction - Gandhi Square stretch with 60 vehicles.

Accident prone locations: 46 accidents were reported in the year 2013, which increased to 54 in 2015. The highest number of 11 accidents was reported at the central area of Kattappana town, followed by seven accidents at Vellayamkudi and four accidents in Palakkad.

Inter-city passenger traffic: An estimated 91,000 inter-city passenger trips were performed in the study region on a reference day.

Inter-city goods transportation: Quantum of goods handled by the goods vehicles was 2,427 tonnes. 815 tonnes of traffic originated from the study region and 911 tonnes of traffic terminated in the study region. More than 623 MT of traffic (25%) are of divertible nature.

Traffic projection: All the major road corridors within the central area of the town would be severely congested in the horizon year with the anticipated traffic more than the capacity of the roads under "do-nothing option".

Proposed Transport Development Plan:

Regional transport connectivity in ensuring the affinity between the block headquarters and other parts of the block is one of the prime needs in the transport development plan of Kattappana town. The town has to meet the needs of a cross section of people with various purposes. All committed development schemes were taken into account while formulating the transport development plan.

As the level of service of urban roads are dictated to a great extent by the capacity of intersections, the development proposals gave importance to increase the capacity of major intersections by proper planning and design. Special emphasis was also given to develop off-street parking lots and also to provide adequate pedestrian facilities in the central business area of the town.

6. Kannur City

Kannur Corporation is spread over an area of 78.35 sq kms with a total population of 232,196 persons as per 2001 India Census.

Traffic volume at major intersections: Thana Junction recorded the highest peak hour traffic volume of 5,102 PCU, followed by Stadium Junction with 4,511 PCU, Mele Chovva Junction with 3,997 PCU, Caltex junction with 3,865, and South Bazaar Junction with 3,686 PCU.

Parking: Plaza area consisting of three roads leading to Thavakkara, Muneeswaran Kovil and Prabhat Junction had the highest peak parking accumulation of 244 vehicles, followed by Mele Chovva area with 214 vehicles and Puthiyatheru with 156 vehicles. Most of these vehicles were found to be two wheelers.

Inter-city passenger traffic: An estimated 4.3 lakh inter-city passenger trips were performed in the study region on a reference day.

Inter-city goods transportation: A total of 11,039 goods vehicles were found to be involved in carrying goods traffic to and from the study region with a quantum of 27,805 MT.

Traffic projection: Almost all the major road corridors in the region would be severely congested in the horizon year with the anticipated traffic more than the capacity of the roads under "do-nothing option".

Proposed Transport Development Plan:

Since the most important problem of Kannur City is the inadequacy of NH 66 and the internal ring roads of Kannur City to cater to the high volume of traffic, the development strategy addressed the issues of traffic congestion comprehensively and adopted adequate capacity augmentation schemes so that frequent and regular traffic hold-ups are minimized. Apart from this, as the proposed developments of Kannur Airport and Azheekkal Sea port are expected to accelerate the passenger and goods traffic in the city, the impact of such developments were also addressed in terms of connectivity to the airport and sea port respectively.

The Kozhikode – Mangalore railway line passes through the middle of the city and the connectivity among the western and eastern parts of the city are hampered due to the same. Very few grade separated facilities are available to cross the railway line and they too are of inadequate width necessitating widening or construction of new Road Over Bridge or underpasses. There is a need for construction of more ROBs to ensure uninterrupted flow of traffic between the eastern and western parts of the city. Parking and pedestrian activities are the major external interferences in the smooth operation of traffic flow in the city and proper regulatory and streamlining measures will serve the purpose of smoothening the flow of traffic. Hence the long range planning of the city's traffic and transportation system deserve to be accorded the right priority.

As the level of service of urban roads are dictated to a great extent by the capacity of intersections, the development proposals gave importance to increase the capacity of major intersections by proper planning and design. Special emphasis was given to develop off-street parking lots and also to provide adequate pedestrian facilities in the central business area of the town.

7. Pattambi Town

Pattambi municipality is spread over an area of 15.84 sq kms with a population of 28,632 as per 2011 India census. Major road of Pattambi was the State Highway from Shoranur to

Perinthalmanna with a length of about 10km within town limits. Pattambi-Guruvayoor road has a length of 2 km and Pattambi-Cherpulasserry road had just 1.2km.

Traffic volume at major intersections: Mele Pattambi Junction recorded the highest peak hour traffic volume of 3,505 PCU, followed by 2,713 PCU at Pattambi Junction, 2,449 PCU at Civil Station Junction, and 2,393 PCU at Kalpaka Junction. Sangaramangalam and Thrithala road Junction had the traffic volume between 1,500 PCU and 1,600 PCU.

Parking Characteristics: Pattambi town as a whole had peak parking accumulation of 380 vehicles at 05.30 PM. Bulk of them (84%) was found to be two wheelers. The road stretch between Pattambi Junction and Bus station had the maximum accumulation of 173 vehicles consisting mostly of two wheelers. Most of the vehicles (83%) parked in the major parking corridors parked for duration of less than 30 minutes.

Inter-city passenger traffic: About two lakh inter-city passenger trips were performed in the study region on a reference day.

Inter-city goods transportation: A total of 6,842 goods vehicles were found to be involved in carrying goods traffic to and from the study region on a day with a quantum of 13,600T. About 60% of traffic was of divertible nature, which, are passing through the CBD area of the town due to non-availability of bypass.

Traffic projection: All the major road corridors like Guruvayoor road, Muthuthala road, Perinthalmanna road, Cherpulasserry road and Shoranur road would be severely congested in the horizon year with the anticipated traffic more than the capacity of the roads under "do-nothing option".

Proposed Transport Development Plan:

The most important problem of Pattambi town is the traffic congestion at the central part of the town especially between Mele Pattambi Junction and Pattambi Junction and also between Pattambi Junction and Pattambi bus station. It is caused by the inadequacy of road width which is not able to cater to the traffic generated by the large number of commercial establishments, public transport terminals - bus station and railway station and numerous public offices located in the close vicinity of the road stretch. The traffic problems get accentuated by conflicting movements of traffic at the major intersections like Mele Pattambi Junction, Civil Station Junction and Pattambi Junction as they are not having sufficient

junction area to handle the conflicting movements. There are huge parking and pedestrian activities experienced on the problematic road stretch which act as the major external interferences in the smooth operation of traffic flow in the town causing frequent traffic holdups.

Pattambi town functions as the headquarters of Pattambi block Panchayat and Pattambi Taluk apart from being a major commercial and trading centre in the region. Hence, the town has to meet the needs of a cross section of people with various purposes. Regional transport connectivity in ensuring the affinity between the block headquarters and other parts of the block is one of the prime needs in this regard.

The development strategy addressed the issues of traffic congestion comprehensively and adopted adequate capacity augmentation schemes so that frequent and regular traffic hold-ups are minimized. While deciding the capacity augmentation measures, the limitation of the widening the traffic bottleneck stretch due to the railway line and Bharatha Puzha passing parallel to the road stretch should be kept in mind.

The development proposals gave importance to increase the capacity of major intersections by proper planning and design. Special emphasis was given to develop off-street parking lots and also to provide adequate pedestrian facilities in the central business area of the town.

Considerable traffic movements are observed between Guruvayoor side and Perinthalmanna/ Shoranur side/ Muthuthala and they are passing through the traffic bottleneck stretch in the absence of other link roads/ bypass roads. Hence the development strategy addressed the issue of providing adequate link roads/ bypasses taking to consideration the present traffic as well as the horizon year traffic.

8. Mananthawady Town

Mananthawady Municipality is spread over an area of 80.01sq.kms with a total population of 45,477 persons as per 2011 India Census. Population density is 782 persons per sq. km of area.

Traffic volume at major intersections: Super Market junction witnessed the highest peak hour traffic volume of 2,660 PCU, followed by 2,520 PCU at Federal Bank Junction and 2,206 PCU at Mysore Road Junction. It was also found that all major junctions were having a Peak Hour Factor (PHF) ranging from 0.8 to 0.95.

Parking: The road stretch from Federal Bank Junction to City Medicals Junction had the highest peak hour parking accumulation of 96 Equivalent car space (ECS), followed by the road stretch between Post Office Junction and Thazheyangadi Junction having 56 ECS and Bus Stand Junction to Federal Bank Junction having 55 ECS. Majority of the vehicles parked on-street belonged to two-wheeler category (about 51%) followed by cars (23%) and passenger autos (11%).

Inter-city passenger traffic: An estimated 1.31 lakh inter-city passenger trips were performed in the study region on a reference day.

Inter-city goods transportation: An estimated 3,090 goods vehicles were found to be involved in carrying goods traffic to and from the study region on a reference day.

Traffic projection: All the major road corridors within the central area of the town would be severely congested in the horizon years with the anticipated traffic more than the capacity of the roads under "do-nothing option", with about 52% of roads exceeding their capacity in the horizon year 2026 and 64% of roads exceeding their capacity in the horizon year 2036.

Proposed Transport Development Plan:

Junction improvement proposals have been recommended for major junctions within the CBD portion of the study area to ensure the smooth flow of traffic through the junctions. On-street parking measures such as implementation of 'no-parking' and parking tickets scheme, and identification of off-street parking lots on vacant plots have been proposed to improve the parking scenario within the CBD area of the study area, where parking is prevalent. At-grade pedestrian crossing facilities in the form of zebra crossings have been proposed at all junctions to ensure the safe crossing of pedestrians. A Foot-over-Bridge has been recommended at Mananthawady Bus Stand junction and Mysore Road junction, where pedestrian-vehicle conflicts were found to be high. It is also recommended to provide footpaths with a minimum width of 1.8m on either side of the road stretches in the study area for the safe movement of pedestrians.

An outer ring road has been proposed in the study area to divert the by-passable traffic plying through the study area. Several widening schemes and proposals for upgrading the existing road network have also been recommended.

Other proposals such as provision of traffic signs and road markings, up gradation of the existing bus stand, shifting of market area near Gandhi Park towards the bypass road, and up-gradation of goods terminal have also been proposed to decongest the CBD portion in the study area.

9. Kottarakkara Town

Kottarakkara town has a geographical area of 17.39 km^2 with a population of 29,788 as per 2011 India census.

Traffic volume at major intersections: Pulamon Junction recorded the highest peak hour traffic volume of 3,606 PCU, followed by 3,190 PCU at Market Junction, Market (TB) Junction with 2,366 PCU and Post Office Junction with 1,756 PCU. Junctions named Muslim Street Junction (1,028), Railway Station (1,026), and Thrikkannamangal Junction (745 PCU) had peak hour traffic volume greater than 750 PCU.

Parking: Of the ten corridors where parking accumulation survey was conducted, parking of vehicles was found to be quite high at the road stretch of 700m length from Municipal Office to Market Junction with 198 vehicles, followed by 117 vehicles on the stretch from Pulamon to KSRTC entry point of length 200m.

Inter-city passenger traffic: About 1.82 lakh inter-city passenger trips were performed in the study region on a reference day. 59% of the total trips were external to internal and internal to external trips. External – external trips were about 41 per cent of the total trips.

Inter-city goods transportation: Quantum of goods handled by the goods vehicles was 6,534 MT. Trucks carried the maximum volume of goods traffic (37%), followed by mini-trucks (36%) and MAT (18%).

Traffic projection: All the major road corridors within the central area of the town would be severely congested in the horizon year with the anticipated traffic more than the capacity of the roads under "do-nothing option".

Proposed Transport Development Plan:

Proposed transport development plan for Kottarakkara town keeps in mind the crux of the existing problems of traffic congestion in the central area of the town and finally devise suitable short and low cost measures, medium and long term measures to ease the general

flow of traffic in the area. The town being in close proximity to two major transit corridors namely a National Highway and a State Highway, is experiencing acute congestion and chaotic situation at the intersecting point of the town namely Pulamon Jn. Accordingly, Conceptual design drawings have been prepared for the major junctions in Kottarakkara town like Pulamon junction, Market and TB Road junction and Kacheri junction.

In addition, keeping the long terms perspectives, a hierarchical pattern of network consisting of primary, secondary and tertiary distributor roads has been proposed. Since the growth and development of Kottarakkara has been in a linear pattern, it is deemed necessary to develop a ring network of roads so that dependence on any single corridor gets fragmented into multiple corridors in a ring radial pattern. Ring roads are proposed for the town to reduce the mixing up of intra-city and inter-city traffic along with detailed alignment plans. Apart from these, development of radial roads of the town like Kottarakkara–Sasthamcotta road, Kottarakkara-Oyur Road and Kottarakkara- Neeleswaram Road have been proposed. Improved road connectivity to pilgrim centres and tourist spots and enhancing the public transport facilities in the town are also recommended.

Proposals for parking and pedestrian facilities and traffic regulation and management are put forth for facilitating the transport scenario of the town.

10. Harippad Town

Harippad is a recently formed municipality in Karthikapally Taluk of Alappuzha district. The two most famous temples in Harippad, Subrahmania Swamy temple and Mannarasala Temple put heavy stress on the already congested transport system of the town during the pilgrim season.

Speed and delay characteristics: The average speed during peak hour of all the roads taken together was 33 kmph whereas during off peak hour, it was 36 kmph. The average journey speed varied between 17 kmph to 51 kmph during peak hours and 23 kmph to 26 kmph during off peak hours.

Pedestrian Volume: High levels of lateral movement of pedestrians were found in front of Taluk hospital followed by in front of KSRTC Stand. Town hall junction had high lateral pedestrian movements in its arms followed by Karthikapally Junction.

Public transport operations: Public transport services are run by both KSRTC and private buses in Harippad Town. KSRTC bus services are operated from KSRTC bus stand located on NH 66 near Taluk Hospital Junction. Private buses board and alight passengers from KSRTC bus stand at Taluk hospital. There is a private bus stand for parking of private buses near Danapady on Danapady - Karthikapally road. Data compiled from KSRTC reveal that 295 trips are operated from/through the KSRTC bus station in Harippad town in a day.

Proposed Transport Development Plan:

A Ring and radial pattern of road network along with development of a number of local roads is suggested for Harippad town. With NH 66 as central axis, 14 radial roads are proposed for Harippad. Two ring roads – one inner ring road and one outer ring road has been proposed in the study area to reduce the mixing up of intra-city and inter-city traffic. The road widening proposal is based on projected volume/count ratio and its functional classification

Conceptual Junction improvement proposals have been recommended for four major junctions within the CBD area to ensure the smooth flow of traffic through the junctions. On-street parking spaces have been identified on major road stretches in the town to regulate on street parking on congested roads in CBD area. As a long term solution, off-street parking facilities at four locations and a multilevel car parking facility proximate to Mannarassala temple are recommended. It is also recommended to provide footpaths with a minimum width of 1.8m wherever possible on either side of the road stretches in the study area for the safe movement of pedestrians. The foot path on the road from Town Hall Jn to Sri Subrahmanya Swamy Temple is proposed to have a separation from carriageway by kerb of 20cm height. Fixing Rail barriers, paving of footpaths with modern tiles, deviation of straight course foot paths at bus shelters to avoid conflict with waiting passengers are the other recommendations proposed to ensure safety of pedestrians.

Segregated bus bays at two locations and a bus shelter at one location have also been proposed. Traffic management plan for Sree Subrahmanya Swamy Temple area has been proposed to accommodate the increasing volume of vehicles visiting the temple during festival seasons.

To maximize the efficiency of rail system, measures for enhancing the integration of rail mode of transport with the other modes of public transport in the town is proposed. Proposal on Integration of bus transport services, other infrastructure improvements etc. have been

recommended. For promoting non-motorized transport in the town, a non-motorized transport friendly corridor has been identified. Other proposals to improve the transport facilities for pilgrim centres and tourist spots, transport infrastructure to promote tourism, plans for better connectivity to Thrikkunnapuzha and NW 3, better connectivity to the proposed Greenfield airport which is a project on anvil as of now and plans for development of Inland Waterway transport have been suggested.

11. Erattupetta Town

Erattupetta Municipality has an area of 7.5 km^2 and holds a population of 29,682 as per the 2011 census.

Speed and delay characteristics: Average speed of travel in Erattupetta town was 25kmph with delay accounting for more than nine percent of the total travel time.

Traffic volume at major intersections: Muttom junction recorded the highest peak hour traffic volume of 2,716 PCU, followed by 2,691 PCU at Ahmed Kurickal Junction, Aruvithura Bank Junction with 2,304 PCU, Central Junction with 2,241 PCU and Aruvithura Church Junction with 2,170 PCU.

Parking: Road stretch between Muttom Junction and Kaduvamuzhy Bus Station had the highest parking accumulation of 164 vehicles parked at a time on a normal working day, followed by the road stretch from Central Junction to Chennad Junction having 128 vehicles, and road from Kaduvamuzhy Bus Station to Muttom Junction with 109 vehicles.

Inter-city passenger traffic: About 1.43 lakh inter-city passenger trips were performed in the study region on a reference day.

Inter-city goods transportation: The quantum of goods traffic handled by the goods vehicles was about 6,640 MT (70%), followed by mini-trucks/goods tempo (6%) and the remaining four per cent of goods traffic by goods autos. 17.71% of goods traffic originated from the study region and 23.58% of traffic terminated in the study region. More than 58% of goods traffic was of divertible nature.

Traffic projection: All the major road corridors within the central area of the town would be severely congested in the horizon year with the anticipated traffic more than the capacity of the roads under "do-nothing option".

Proposed Transport Development Plan:

On the basis of the projected volume of traffic and alternative network development schemes considered, a road development plan has been formulated for Erattupetta town. As per the future road development plan for the town, the proposed network consists of radial roads complemented with circumferential roads to form a 'ring and radial' pattern of urban network.

It is proposed to shift the existing private bus stand to Thazhathu Nadackal, opposite to MGHSS, Erattupetta. To facilitate efficient and economic operation of goods transport, infrastructural facilities for goods terminal is proposed in between Kaduvamuzhy and Muttom.

It is proposed to provide pedestrian walkway from Kaduvamuzhy Bus Station to MES Junction on SH32, Thottamukku to Chennad Junction on SH 44 and MES Junction to Nadakkal on SH 14. As most of the roads in the CBD area do not have adequate width to accommodate on street parking, it is proposed to develop off street parking facilities.

In an era of advanced information technology, use of Intelligent Transport system should be utilized for enhancing the traffic flow management and in related fields.

8. Feasibility of a Grade Separator at Mokavoor in Kozhikode city

A proposal to develop the Kozhikode Bypass into a six-lane carriageway is under the consideration of the Ministry of Road Transport and Highways, Government of India. At this juncture, a request has come from the residents of Mokavoor region in Elathoor Panchayat in Kozhikode district to provide a safe and secure travel environment to them. The Kozhikode bypass section of NH 66 runs along this area and is highlighted by the presence of three intersections within a distance of 750 m, namely Ambalam junction, Peringini Junction and Kuniyil Thazham junction **(Figure 4**).

The Mokavoor region is spread on the western side of Poonoor River (**Figure 5**). Once the NH bypass is constructed, the area will be divided with about 400 settlements on the eastern side getting isolated from the rest. These people nevertheless have to cross the bypass for fulfilling many of their activities and services.

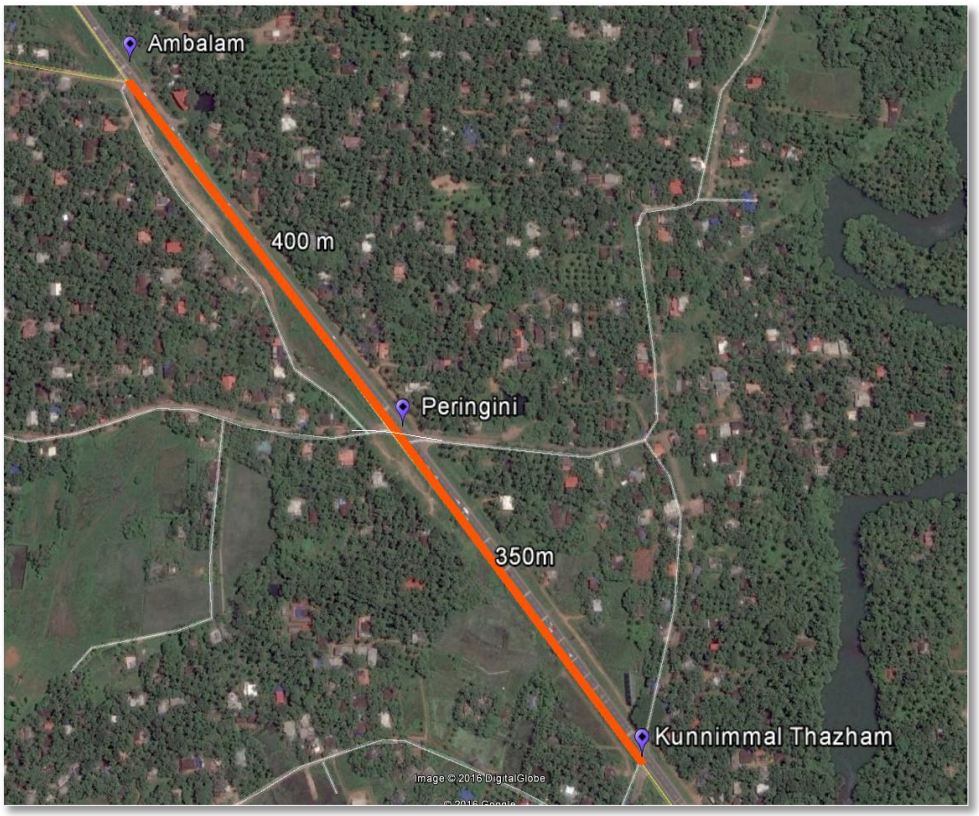


Figure 4: Kunnimmal Thazham –Stretch of Kozhikode Bypass

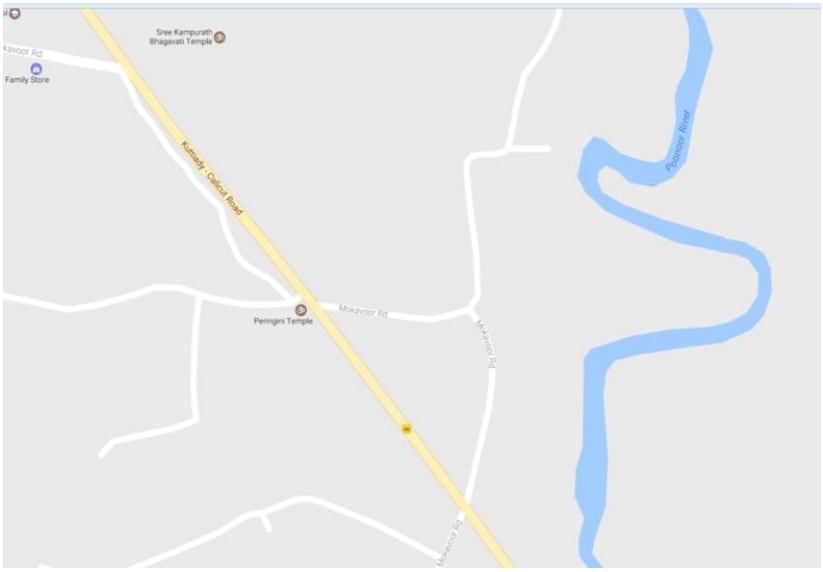


Figure 5: Map of Mokavoor Area

Once the 4-laning work of NH bypass is complete, the local people will have to cross the 4 lanes of NH - about 20m – excluding the service road width, for satisfying their daily needs. This will add more chaos to the situation and will warrant provision of power controlled

signals. As it is not recommended to have signalized intersections at very short intervals in an NH, other measures are to be thought of.

Since it is not possible/advisable to provide at grade crossing facilities at these junctions, NATPAC has recommended that grade separated facility may be provided in the area. The facility may be in the form of an underpass (Vehicular Overpass for NH) and considering the cost and construction issues, it is adequate to provide one underpass for the Chittadikadavu road at Peringini junction. The services along other two junctions viz Ambalam junction and Kunnimelthazham are to be located through the underpass junction at Peringini. The underpass will help in providing safe and secure travel for the local residents of the Mokavoor area as well as better service to the NH traffic.

9. Comprehensive Mobility Plan for Thrissur City in Kerala State

Introduction

Comprehensive Mobility Plan (CMP) is a technical document containing short, medium and long term schemes and action programs, to ensure mobility needs the goods and people in a safe and sustainable manner, with the integration of land use and transport development. CMP is a prerequisite for availing financial grant for major schemes from Ministry of Urban Development, Government of India. NATPAC has embarked on the preparation of the document for Thrissur City in Kerala state as part of Plan program of the centre for two years starting from 2016-17.

Major objectives of the study have been set as per guidelines of Ministry of Urban Development, Government of Kerala as follows;

- To understand the present day travel characteristics and forecast them for the horizon year(s);
- To develop a transportation vision and goal for desirable urban development of the city;
- To identify specific land use and transport strategies and measures to be implemented for a span of 20 years or more;
- To prepare an implementation program of proposed strategies and measures along with their cost estimates.

Methodology adopted for the study

Based on a preliminary reconnaissance and a clear-cut understanding of the requirements of the CMP, a systematic, phased and integrated approach is formulated for conducting the study and delivering the results within the stipulated timeframe. The study was conducted through eight major activities:

Activity 1 : Mobilization and Reconnaissance
Activity 2 : Establish current transportation trends, gaps and travel characteristics
Activity 3 : Urban Travel Demand Modeling
Activity 4 : Travel demand forecasts
Activity 5 : Development of Urban Mobility Plan
Activity 6 : Implementation and Regulatory and Institutional Mechanism
Activity 7 : Stakeholder Workshop
Activity 8 : Comprehensive Mobility Plan Report

The data collected from the field are being analyzed to extract inputs for the preparation of CMP including:

- Development of base year OD matrices
- Travel demand Model development using Cube software for
    - Trip Generation - estimating number of trips originating from and destining in each zone
    - Trip Distribution – attaching the origins and destinations for each trip between zones
    - Mode Choice – determining the mode of travel for each trip
    - Traffic Assignment – establishing routes and transit networks
- Assignment and Validation of traffic at screen line/ cordons
- Travel demand forecast
- Development of urban mobility plan
- Planning of long, medium, short term/ immediate improvement measures
- Implementation plan – cost estimate, phasing, implementing agencies
- Stakeholder workshop

Brief profile of study area

The study area consisted of Thrissur Corporation, eight adjoining panchayats and one municipality with a population of 12.47 lakhs residing in 3.14 lakh households as per 2011 census.

Status of project

All the necessary data collection for the study through both primary and secondary sources has been completed. Data analysis is in progress and final report shall be prepared during the next plan period 2018-19.

10. Parking Management Schemes for Medical College Area in Thiruvananthapuram

Background

Thiruvananthapuram Medical College is one of the high activity areas in the city due to the location of Medical College Hospital. The area witnesses severe traffic problems caused by increasing vehicular traffic, pedestrian criss-cross movements and large volume of parked vehicles at almost all possible parking areas. Within the campus, the vehicles are parked in a disorganized and haphazard manner encroaching the carriageway and obstructing the footpath at many locations of the campus. As the overall situation affects the movement of vehicles ferrying patients to the Medical College, office of the Chief Minister, Government of Kerala directed NATPAC to prepare parking management plan for the area considering the existing parking demand and long term traffic solutions. Accordingly the centre undertook the task of preparation of parking management schemes for Medical College area.

Tasks carried out as part of the study

As part of the study, the centre compiled necessary data through primary surveys and secondary sources. They included categorized volume count survey, pedestrian surveys, parking studies and evaluation of public transport facilities and road safety aspects. The data compiled were utilized to make an assessment of traffic improvement measures and transportation system management measures. The basic design elements like parking turnover, parking accumulation, vehicle occupancy rate etc. were studied. Based on data analysis, improvement schemes to alleviate congestion and resolve the traffic related issues of the study area were formulated

Inputs obtained for the study

Parking demand: Based on analysis of data, an assessment of parking demand and supply characteristics based on which the parking deficiency is estimated. Total peak hour parking demand estimated is given in **Table 3.**

Table 3: Total peak hour parking demand

Type of parking	Total Demand(ECS)
On-street	1,243
Off-street	794
Total	**2,037**

Parking supply: As per IRC, the standard dimensions of a car are taken as 5x 2.5 meters, and this was suitably applied on the area and road length details to arrive at the existing supply of parking spaces. The total off street parking space available in the medical college campus is around 10,000 sq.m and is located at various locations of the medical college premises. The available parking space includes the road side/ on street parking. Hence, the current supply in terms of parking within the campus is for around 400 Equivalent car space (ECS).

Parking statistics: The data collected were analyzed to retrieve the parking statistics like parking duration, parking accumulation, parking turnover, parking load, average parking duration and parking index. An analysis of **parking duration** shows generally for most of the locations that around 60 to 70 % of vehicles were parked for less than 60 minutes. As per the parking accumulation curves, the peak hour demand for most of the location was between 10.00 A.M. to 12 noon; that is during the Out Patient hours at the Medical College Hospital. **Parking turnover** is the rate of the usage of the available parking space and is found to be 5.1. The total parking load was worked out to be 5,424 vehicle hours. The average parking duration was found to be 61 minutes which means that short-time parking was more prominent in the campus. **Parking Index** is defined as the ratio of number of bays occupied in a time duration to the total space available. The parking index for off-street parking locations ranged from 1.49 to as high as 4.04 with an average of 2.29.

Study recommendations

Total parking space available in the medical college campus can house around 400 ECS comfortably with sufficient maneuvering space. However, the peak demand is 2,037 ECS far higher than the supply. This implies that there is no sufficient space to park the vehicles and the vehicles are parked everywhere causing traffic congestion in the campus. Considering the

fact that there is an excess demand but the area is limited and also the fact that parking outside the college premises will cause inconvenience for the users, it is recommended that a Multi-Level Car Parking facility can be provided at a location slightly away from the main road for meeting the parking demand on a long term point of view. This will lead to maximum utility for the land area by providing maximum number of car parking spaces on different floors of the multi-level car parking building. Two locations have been identified for constructing MLCP. The conceptual plans of the MLCPs are given in **Figures 6 and 7**.

The other traffic improvement schemes suggested include the following schemes:

- Plans for capacity enhancement of the road network wherever required;
- Improvements in traffic circulation plan;
- Provision of traffic signs and road markings as per guidelines;
- Erection of camera to check violation of traffic regulation;
- Demarcation of at grade and multi-level parking facilities;
- Plans for improvement of pedestrian facilities;
- Recommendations for the improvement of safety aspects of the road network;
- Suggestions for the improvement of efficiency and access to the public transport.

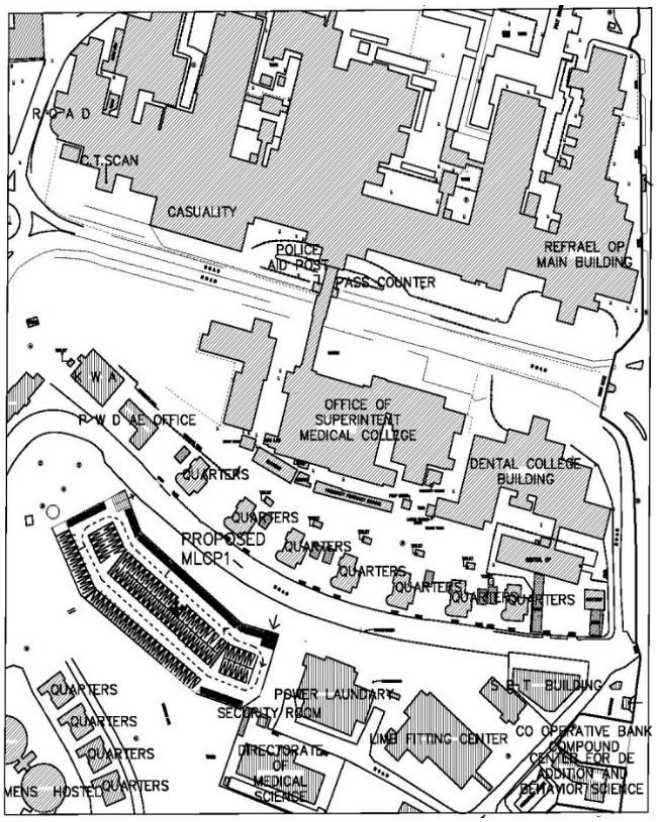


Figure 6: Conceptual plan for proposed MLCP 1

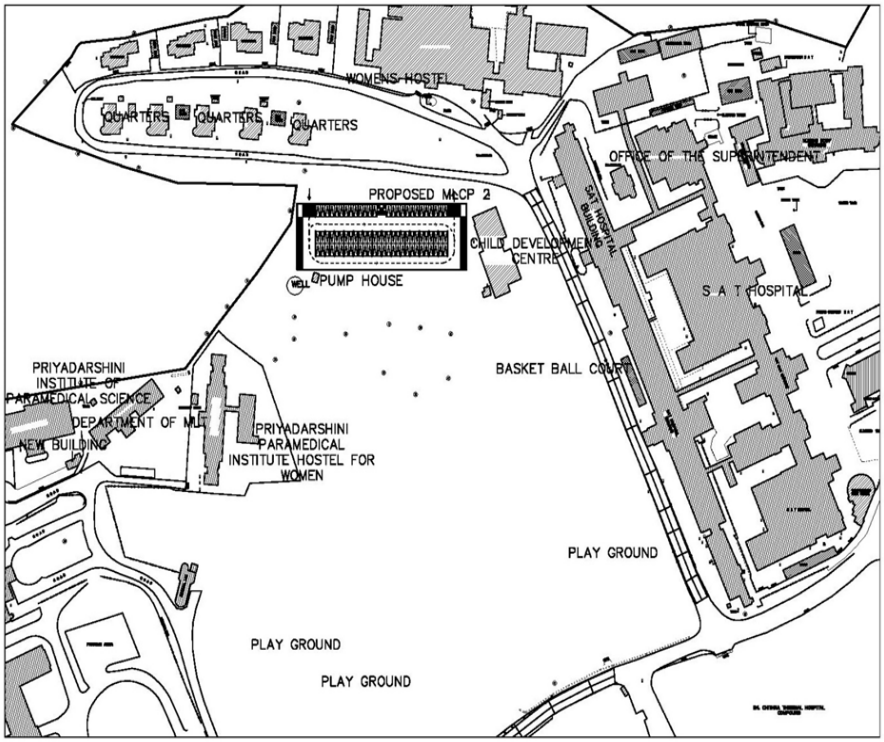


Figure 7: Conceptual plan for proposed MLCP 2

11. Pedestrian Grade Separated Facility at three Pedestrian Intensity Areas in Thiruvananthapuram City

Study background

Cotton Hill Girls Higher Secondary School area, Vazhuthakkad, Pattom-Kesavadasapuram road and East Fort area are three major pedestrian intense areas in Thiruvananthapuram city. As these high pedestrian areas are located on the busy road corridors, the pedestrian movements have severely affected the vehicular movement on the main roads apart from putting the pedestrians especially school children in high safety risk. In this context, NATPAC has carried out a pre-feasibility study for providing grade separated pedestrian facility at the three locations. The following tasks were carried out as part of the study.

- Pedestrian demand assessment;
- Assessment of land availability at the project location;
- Preparation of base map showing the proposed location;

- Setting design standards for grade separated facility with access ramps.

Study outcome

Cotton Hill high school witnessed about 700 pedestrian cross movements during peak hour. Base plan of the area showing the pedestrian movements is shown in **Figure 8**. Pattom Kesavadasapuram road in front of St Mary's High school has about 3,000 pedestrian crossing during peak hour while in front of Government Girls High school, it was about 200 (**Figure 9**).

As a solution to pedestrian – vehicle conflict, subways were proposed at the two locations as per specifications of ramp as shown in **Table 4** and requirements of subway as per **Table 5.**

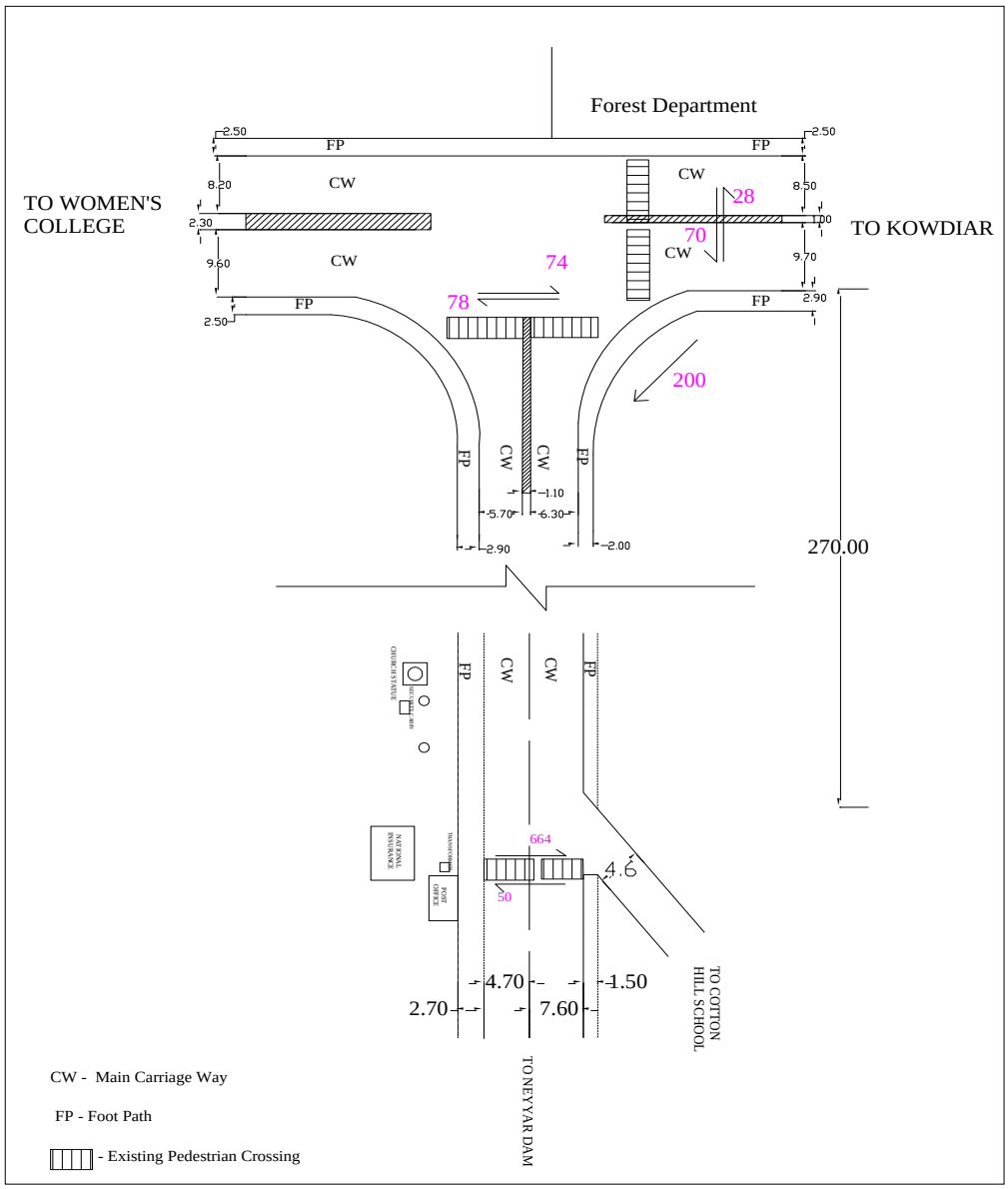


Figure 8: Base Plan and Pedestrian Count Data at Cotton Hill School Area

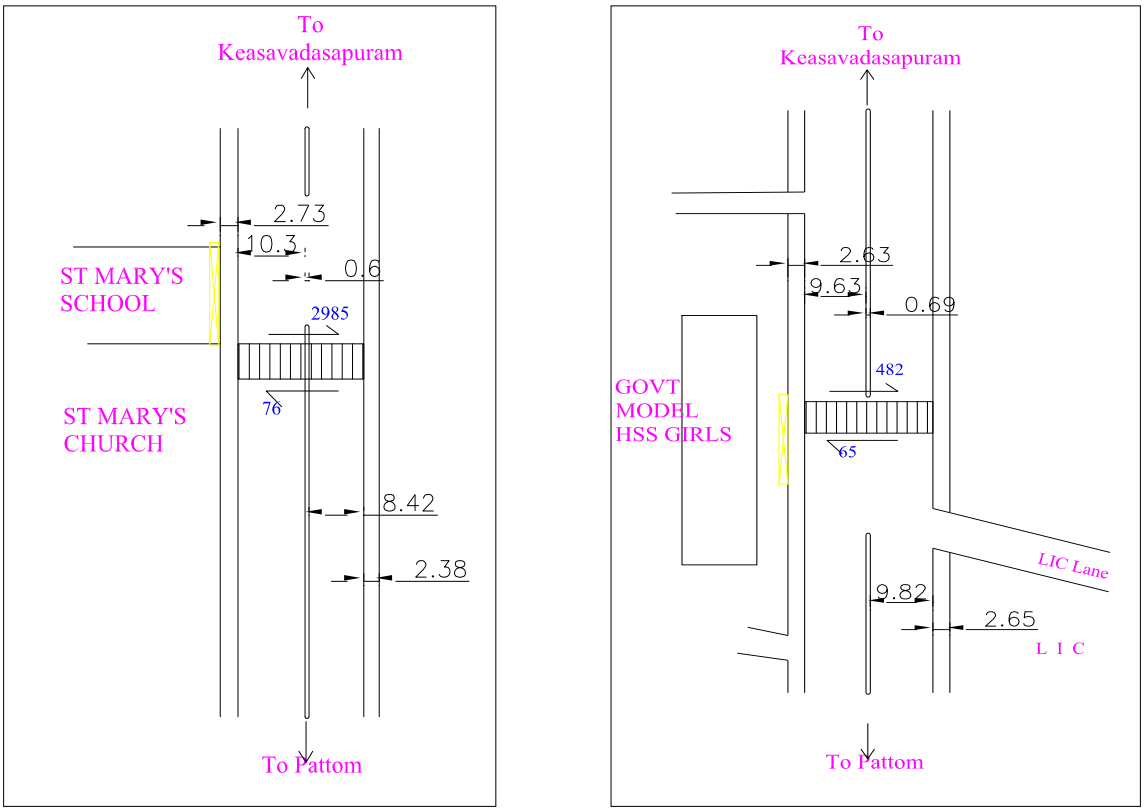


Figure 9: Base Plan and Pedestrian Count Data at Pattom – Kesavadasapuram Road

Table 4: Minimum Specifications for Ramp

Level difference	Minimum gradient	Width	Comments
150mm <= 300mm	1:12	1,200mm	-
300mm <= 750mm	1:12	1,500mm	Landing every 5 meters
750mm <= 3000mm	1:15	1,800mm	Landing every 9 meters
>= 3,000mm	1:20	1,800mm	Landing every 9 meters

Source: Table 6, IRC 103:2012

Table 5: Requirements of Subway

Width	4.8m
Vertical Clearance	2.75m
Visibility	Clear view from one end to the other. Good level of lighting (50lux minimum)
Security	CCTV providing full coverage. Small shops.
Ventilation	Ensure natural lighting and ventilation. Subways with 40m length should be provided with forced ventilation facilities.

12. Provision of Pedestrian Crossing Facility at East Fort Area in Thiruvananthapuram city

Background

East Fort is a main hub for commercial, transportation and other recreational activities in Thiruvananthapuram city. Location of Sree Padmanabha Swamy Temple, City bus terminal, and Chalai Market are the major traffic generating points in the area causing extensive pedestrian criss-cross movements. Most of the public buses which include KSRTC as well as private buses have its destination at East Fort. The higher number of bus maneuvers and heavy pedestrian zigzag crossing movements affects the smooth flow of traffic in this stretch and has led to many fatalities. All these warrants immediate provision of grade separated facilities for the pedestrians in the area. Realizing the same, Transport Commissioner, Government of Kerala entrusted NATPAC to suggest appropriate location(s) for erecting pedestrian foot over bridge at East Fort.

In order to suggest appropriate locations for pedestrian foot over bridge, NATPAC had a detailed reconnaissance of East Fort area. In addition, pedestrian demand in the area was assessed by conducting pedestrian volume count and accident statistics were compiled.

Proposal for Pedestrian Grade Separated Facility

The East Fort area was analyzed on the basis of increasing number of pedestrians, pedestrian related accidents and congestion. Accordingly, three foot over bridges with escalators has been proposed for the easy and safe movement of pedestrians and vehicles at this area. The first one serves two crossings and is located near to the Attakulangara side for facilitating the cross movement of pedestrians to the Chalai road as well as along the main road. The second one serves pedestrians from the side of KSRTC Depot to the Gandhi park for separating from the vehicles to the Chalai side and the third foot over bridge is near to the Pazhavangadi Temple facilitating the cross movement of people near Pazhavangadi side along the main road.

For the effective utilization of foot over bridge, the following points are to be ensured:

- Continuous pedestrian guard rails along the footpath at both sides of the road;
- Continuous pedestrian guard rails with only two openings around the Gandhi park;
- Continuous guard rails are to be provided at median;

- Providing two bus bays in between existing bus shelter and "Kotta Mathil" by demolishing shops here and evacuating the street venders;
- Strong enforcement from the part of Police and RTO.

13. Evaluation and Optimization of Auto Rickshaw Operations in Thiruvananthapuram City

Introduction

Public Transport (PT) is the major mode of transport in Thiruvananthapuram city having a share of 40 percent. Apart from PT, a significant number of Intermediate public transport (IPT) trips are performed in the city with a share of little more than 10%**.** Among the IPT modes, auto rickshaw is the major one. Due to its easy maneuverability, it is posing a still competition to PT in the city. However, it has the disadvantages of causing many road accidents as well as emitting high level of pollutants. There is thus a need to evaluate and optimize the auto rickshaw operations in the city with a view to streamline their operations as a supplementary mode of operation to PT. Accordingly, as part of plan program of centre during the year 2016-17, this study has been taken up.

The major objective of the study was to present a comprehensive understanding of auto rickshaw sector in Thiruvananthapuram city. The scope of the study is limited to regular auto rickshaw operation in Thiruvananthapuram. Other services like auto rickshaw operation for transportation of school children were not covered under this study.

Methodology adopted the study

The methodology adopted for the study consisted of collection of necessary data through primary and secondary sources. Secondary data regarding number of autos in operation at the five prepaid counters and trips performed during the last two months were compiled from Traffic Police who were operating the counters. Growth data in auto rickshaws were compiled from Motor Vehicles. Crashes involving autorikshaws were obtained from State Crime Records Bureau. Opinion survey was conducted among auto drivers to get their operational characteristics. The data collected were being processed for extracting necessary inputs for the study.

Study outcome

Growth in auto population: Population of autorikshaws in Thiruvananthapuram city has increased from 33,308 in 2006 to 75,882 in 2015 showing a growth rate of 8.58% per year (**Figure 10**).

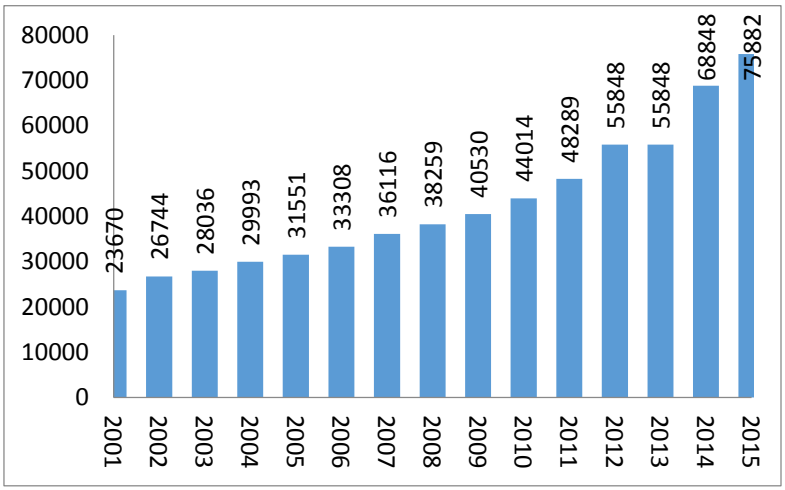


Figure 10: Growth of Auto Rickshaw in Thiruvananthapuram

Crashes involving autos: Crashes involving auto rickshaws were 11 to 15 of the total crash reported in the city during the period between 2008 and 2015 (**Table 6**).

Table 6: Crashes involving autos

Year	Total Crashes	Auto Rickshaw Involved Crashes	% of Crashes
2008	1,538	250	16.25
2009	1,455	205	14.09
2010	1,211	147	12.14
2011	1,515	200	13.20
2012	1,709	228	13.34
2013	1,813	225	12.41
2014	1,764	225	12.76
2015	1,832	214	11.68

Pre-paid auto trips: A total of about 3,000 pre-paid trips were performed from the five pre-paid auto rickshaw booths available in Thiruvananthapuram city on a normal working day. It decreased to 2,819 during holidays (**Table 7**).

Table 7: Pre paid Auto Rickshaw trips

Name of the Prepaid Booth	Average Daily Trips During Working Day	Average Daily Trips During Holiday	Peak Hour	Peak Hour Trip
Central Railway Station	1,327	1,210	10:00 to 12:00	157
KSRTC Bus Terminal	735	725	08:00 to 10:00	227
East Fort	400	450	10:00 to 12:00	78
Pettah Railway Station	348	280	08:00 to 10:00	104
Medical College	194	154	16:00 to 18:00	28
Total	**3.004**	**2,819**		**594**

Major destinations from the prepaid counters were found and distributions of trips to the destination were also arrived. Variations of trips over different days of the week, distribution of trips during day and night period etc. were also found out.

Operational characteristics of autos: Interview was conducted with Auto Rickshaw drivers to get the details of the trip made on the previous day (typical working day). The survey was conducted on major auto rickshaw stands in Thiruvananthapuram city. Operational characteristics obtained from the survey are summarized in **Table 8**.

Table 8: Operational Characteristics

Parameter	Value
Average Hours of Operation	10 Hrs
Average Daily Kilometers Travelled	105km
Average Share of Empty Kilometers Travelled	30%
Average Trip Length	3.5km
Average Daily Trips	16

Further work

Based on trip details obtained from the auto rickshaw drivers, empty trips will be arrived and attempts will be made to optimize auto rickshaw trips.

14. Trivandrum International Airport - NH Access

The approach road to Thiruvananthapuram International Airport lies between Chakkai Junction and Eanchakkal Junction and originates from the side of existing NH-66 bypass through a ramp on the western side. Since the approach ramp to the entry/exit ramp of airport falls within the land demarcated for the construction of additional main carriageway of four-

laning as per the widening plan, National Highway Authority of India (NHAI) has proposed to demolish the ramp on the NH side. As a result, the access to the airport needs to be revised. In this context, at the instance of Chief Secretary, Government of Kerala NATPAC has prepared a report containing access planning for the airport by strictly following the available Indian Standards.

As part of the study, an appraisal of existing traffic situation was made at the first stage, which was followed by framing of alternate proposals, critical evaluation of alternatives with analysis of pros and cons, discussions with various authorities and experts and finalization of alternatives.

Keeping in mind the future widening of National Highway, NATPAC came up with four possible options and submitted to the government. The four options are:

1. Provision of an elevated NH corridor covering Chakkai Junction and ending before Eanchakkal Junction.
2. Demolishing the existing Entry/Exit Ramps of Airport and connecting the airport road directly to the NH service road.
3. Demolishing the existing Entry/Exit Ramps of Airport and connecting the airport road directly to the NH carriageway.
4. To bring the level of National Highway to the level of exit/entry ramp of Airport.

Among the options, option 3 i.e. direct entry to the main carriageway from the airport traffic was accepted by all the authorities. The matter was presented before the Chief Minister of Kerala on 18th July 2016. Since the option demanded demolition of approach ramp, it was decided to constitute a technical committee to identify and recommend other possible options. Dr. N. S. Srinivasan, Highway and Traffic expert was included as special invitee in the committee.

Dr. N. S. Srinivasan presented two options in front of the expert committee as well as the high level committee consisting of Chief Secretary and additional Chief Secretaries of Kerala government.

1. A two-lane uni-directional flyover in front of the airport approach road is suggested for the NH traffic from Eanchakkal side to Chakkai side and to lower the level of airport approach ramp to the level of National Highway. The National

Highway in front of the airport approach is to be raised by one meter for getting a slope of 1 in 20.

2. A two-lane uni-directional flyover in front of the airport approach road, from Eanchakkal side to Chakkai side. An underpass is to be constructed across the airport approach ramp (main ramp) with suitable vertical clearance (3.50 to 4.0 meters) to achieve uninterrupted traffic flow in the service road. A view of this alternative is shown in **Figure 11**.

Figure 11: View of Alternative II suggested by Dr. N.S. Srinivasan

The second option which proposed minimum alterations to the existing structures and no further land acquisition was approved by both the committees and was put forward to the Government of Kerala for taking it further to the Government of India.

15. Assessment of Land Requirements for Parallel Taxiway in the Trivandrum International Airport

Trivandrum International airport is expecting heavy air traffic in the coming years. Construction of a parallel taxiway is a major concern as the structures in some locations are not presently maintaining clear distance from the runway as per the standards. In this regard, at the instance of Thiruvananthapuram Airport authority, NATPAC determined the land required for the construction of parallel taxiway as well as maintaining clear distance from the runway to satisfy the standards. The scope of the work was limited to the northern part of the runway.

Land requirement as per standards were determined based on Total Station survey of the area and preparation of drawings using Auto CAD.

The land acquisition requirement for 150-meter clear space from the centerline of runway with 5 meter wide service road and 150 meter clear space with 10 meter wide service road were prepared in Auto CAD. The first option requires an additional land of 7,292 square meters and the second option requires an additional land of 10,588 square meters.

16. Rebuilding Alappuzha - Concept Report

Background

The Government of Kerala is in the process of improving Alappuzha city and taking it back to its past glory with the motto "Rebuilding Alappuzha" by means of conserving the heritage structures and also integrating and improving canal and road network on a short term and long term basis. In this regard, NATPAC prepared a Concept Report with the following objectives:

- To ensure sustainable growth of the city with adequate infrastructure needs. This is to be provided with a sense of aesthetics;
- To address the traffic and transportation associated problems of the city;
- To improve the city to a world class destination.

Contents of Concept Paper

Road network in Alappuzha city is in the form of a grid pattern, connecting most of the central parts of the town. But the drawbacks such as narrow roads, poor geometrics, unorganized parking, heavy pedestrian movement, poor surface conditions and encroachments cause heavy congestion in the city. In order to improve the road transportation structure in the city, certain roads has been identified and the improvement measures has been suggested.

Short term improvement measures suggested for roads include pedestrian footpath, pedestrian guard rails, pavement resurfacing, road markings, road signs, arboriculture, parking management, removal of encroachments, street lighting and development of cycle track. Long term proposals include development of ring roads/bypass, road widening, intersection improvement, landscape development, provision of bus bays, mobility hubs and pedestrian facilities, development of cycle circuit, provision of parking facilities like

multilevel parking and improvement of cross drainage structures. Road widening has been proposed as per cross section given in **Figures 12, 13 and 14** for a ROW of 16m, 12m and 26 m respectively. The rough cost estimate for the suggested short term and long term road transport improvement measures have been worked out and amounts to Rs.52.57 crores and Rs.586 crores respectively.

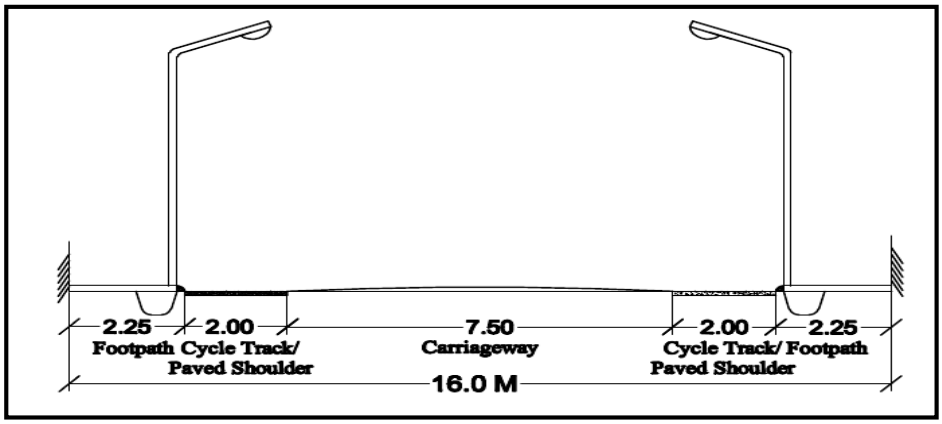


Figure 12: Proposed cross section of roads of ROW within 16m

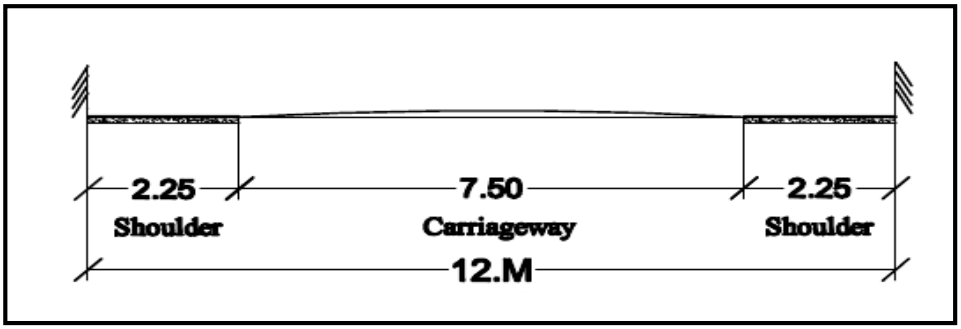


Figure 13: Proposed cross section of roads of ROW within 12m

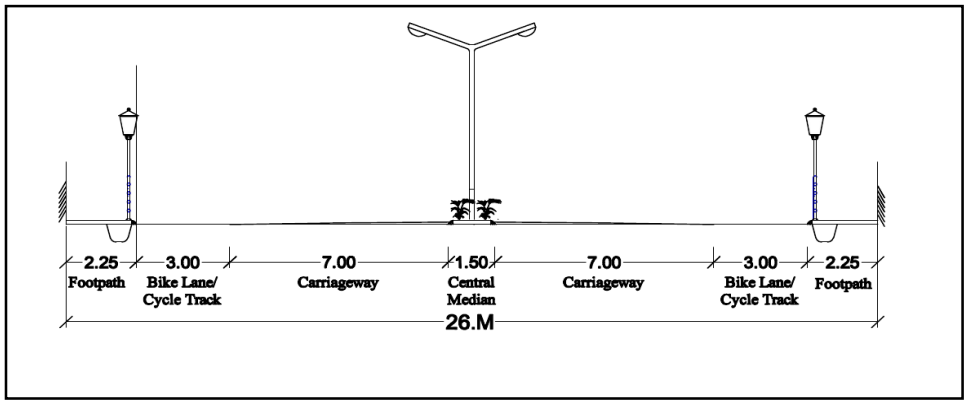


Figure 14: Proposed cross section of roads of ROW 26m

Development of Canals*:* Selected stretches canals in Alappuzha **(Figure 15)** is proposed to be improved in two phases. The rough cost estimates for the development of canals in Phase I amounts to Rs. 36.52 crores.

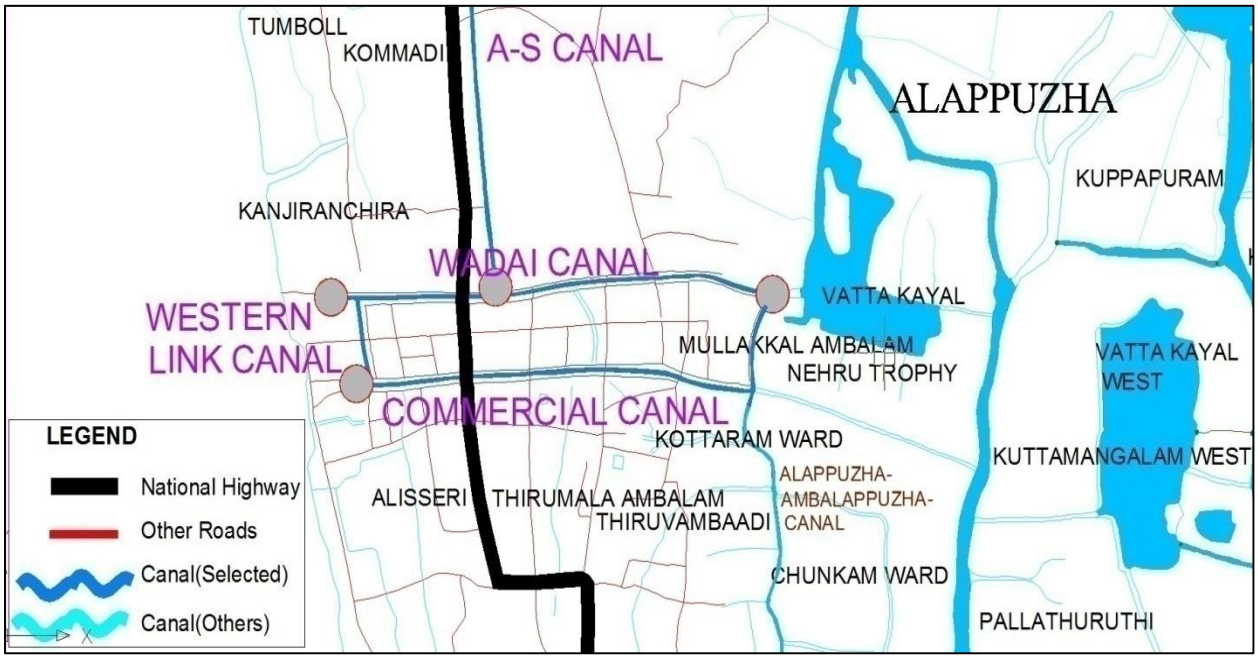


Figure 15: Selected Canal Stretches

The study recommendations are classified as short term and long term based on their importance and the time expected for their implementation. As per the suggested improvement measures, a total of Rs. 689.22 crores is estimated to account for road transport improvement, short term improvement of canals and preservation of heritage structures.

17. Study on the Performance of Highway Development Projects in Kerala

NATPAC carried out a study for the appraisal of the performance of highways developed under Kerala State Transport Project (KSTP). An evaluation of the pavement performance was made by collecting data on pavement performance in terms of deflection, roughness, skid resistance, texture and condition of the pavement surface which will contribute towards assessing the benefits of the highway development projects.

The scope of the study is limited to selected stretches of SH-1 developed under Kerala State Transport Project. As part of the study, the centre collected baseline traffic and transportation data, and made structural and functional evaluation of the pavements by developing a pavement performance prediction model.

Study roads strengthened under KSTP showed good structural performance as indicated by lower deflection values. However, the study roads had bad surface conditions as indicated by low skid resistance value. The study roads exhibited a current functional performance of good to average rating based on the unevenness values indicated by the IRI values of the study stretches. Signs of impending failures have surfaced on the pavement surface of the study roads in the form of various distresses like fractures or cracks, distortion, disintegration etc. Raveling cracks and bleeding were the major distresses seen on the pavement surface. Initiation of potholes and rutting were also noticed at some of the locations.

Three models were developed for predicting the performance of the road. The developed performance models are deflection model, skid resistance model and IRI model. These models were validated to ensure their better use in field conditions.

18. Pavement Design for Ambalappuzha – Tiruvalla Road in Alappuzha District

Background

At the initiative of Public Works Department, Government of Kerala, NATPAC undertook the task of formulating pavement design strategy for the road stretch from Ambalappuzha – Podiyadi section in Alappuzha (**Figure 16**). The main objectives of the study were:

- To study the existing traffic characteristics along the project stretch;
- To study the performance of pavement related to the deflection of the flexible pavement measured by Benkelman beam;
- To study the properties of the subgrade soil of the existing pavement along the project stretch;
- To recommend rehabilitation measures for the existing pavement and new pavement design for the deteriorated sections.

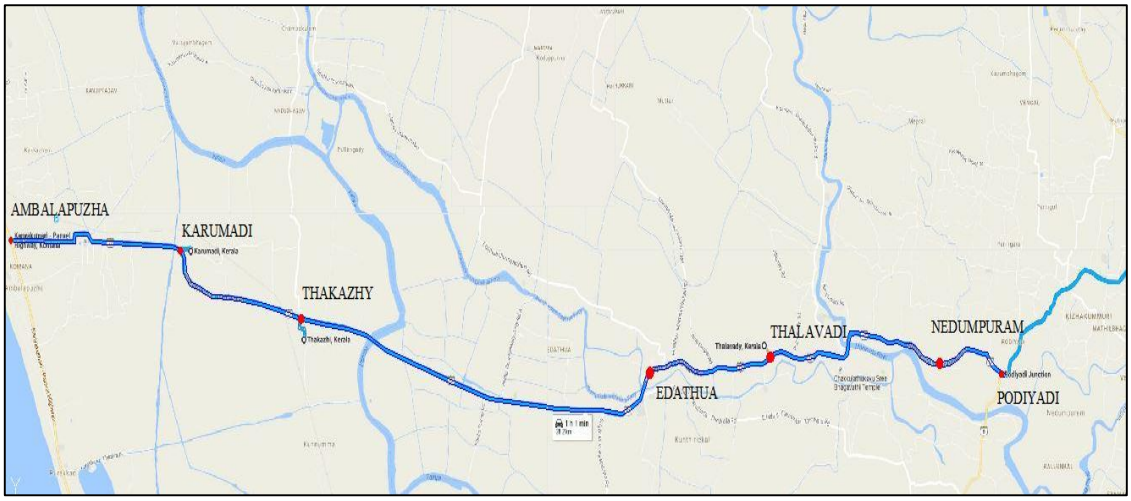


Figure 16: Project stretch from Ambalappuzha to Podiyadi along SH 19

Tasks carried out

A detailed reconnaissance and road inventory survey was conducted to appreciate the topographical features and typical physical features along the project site. During the survey, a visual inspection of the condition of the pavement throughout the project stretch was also undertaken.

Subgrade soil samples were taken from 10 locations along the corridor of the project road. It was found that the subgrade soil was mostly sandy with different percentage of fines. In general, they could be classified into silty sands, highly compressible silt and poorly graded silty sands with little fines.

Pavement Condition Survey was done for collecting the basic information of the road structure and based on this, the road was demarcated into sections of more or less equal/ uniform performance or sections of similar characteristics to obtain homogeneous sections.

Benkelman Beam Deflection Test: Structural strength survey for existing pavement using Benkelman Beam Deflection Technique (BBD) was carried out in accordance with the procedure given in IRC: 81-1997. The deflection varied from 0.55 mm to 3.28 mm for the different sections.

Design of new Pavement and Strengthening of existing Pavement

Based on careful review of the strength parameters and their inter-relationships along with traffic considerations, homogeneous section-wise division of the corridor has been worked. For initial 2 km and last 2.5km, the mean deflection value was 0.81 mm and 0.75 mm respectively and the pavement surface condition was observed to be in good to fair condition. Moreover, the soil characteristic in the section was also found to be good. Hence it was found adequate to provide overlay for those sections. For the sections from chainage 2km to 20km, the pavement was heavily damaged and was full of distress. Also the deflection obtained was high (ranging from 1.30 to 3.27 mm). Under such circumstances, it was not desirable to overlay the existing surface which will result in premature failure of pavement only. Hence, it was recommended to reconstruct the pavement for the sections from 2km to 20km.

The design of overlays for the existing pavement was carried out taking into account the traffic and strength of the existing pavement based on detailed pavement investigation including BBD testing. The stretches identified for reconstruction were highly distressed with extensive cracking and raveling, and hence it was not desirable to overlay such surface. Overlay on these stretches will result in reflection cracking in due course of time and will increase the maintenance cost. Hence new pavement construction was recommended for these stretches.

19. Improvement of Intersections in Nadukani-Parappanangadi Road in Malappuram District

At the instance of Public Works Department, Government of Kerala, NATPAC prepared improvement proposals for six major junctions in Nadukani – Parappanangadi road in Malappuram district viz. Nelliparamba, Thurakkal, Kacherippadi, Munduparamba, Machingal and Kizhakkethala.

Plate 1: Kacherippadi Junction

Plate 2: Munduparamba Junction

Keeping in view the existing traffic characteristics (**Figure 17 & 18**), improvement proposal for the six major junctions was prepared as per relevant IRC standards. Minor deviations on the set standards have been made at certain locations so as to minimize land acquisition. All junctions have been designed adequately for the safe and smooth movement of vehicles as well as pedestrians. Proper realignment of the medians in the approach roads were proposed to increase the capacity of the junctions. Road markings and traffic signals has been proposed for proper guidance of the vehicles. Zebra crossings were also proposed at all the junctions for the safer movement of the pedestrians.

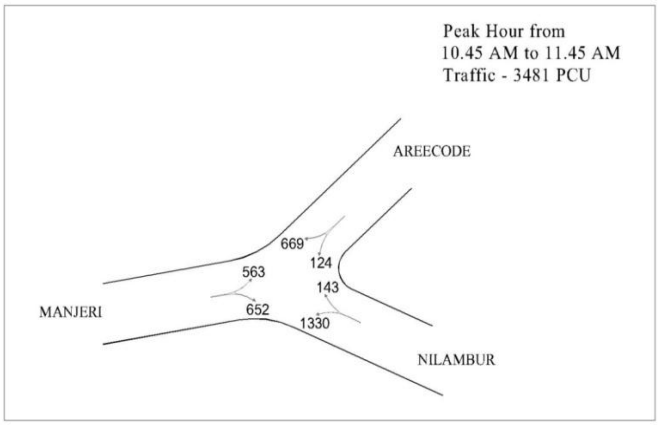


Figure 17: Peak Hour Traffic flow at Nelliparamba Junction

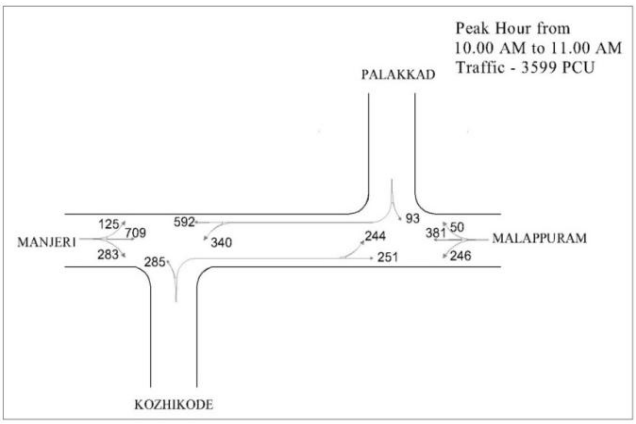


Figure 18: Peak Hour Traffic flow at Munduparamba Junction

20. Pavement Design for Nadukani-Parappanangadi Road in Malappuram

Background

At the initiative of Public Works Department, Government of Kerala, NATPAC undertook the task of formulating pavement design strategy for the road stretch from Nadukani-Parappanangadi Road in Malappuram District (**Figure 19**).

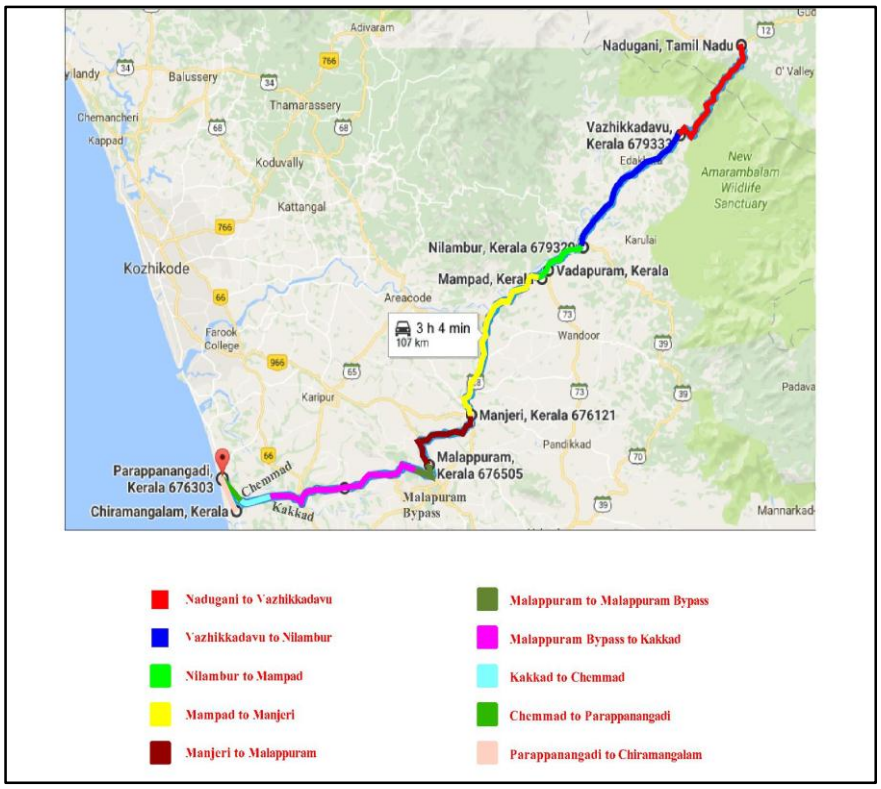


Figure 19: Study Stretch

The main objectives of the study were:

- To study the existing traffic characteristics along the project stretch;
- To study the performance of pavement related to the deflection of the flexible pavement measured by Benkelman beam;
- To study the properties of the subgrade soil of the existing pavement along the project stretch;
- To recommend rehabilitation measures for the existing pavement and new pavement design for the deteriorated sections.

The scope of the study was confined to the design of pavement for the stretch starting from Nadukani to Parappanangadi passing through the towns Manjeri and Nilambur.

Tasks carried out as part of the study

A detailed reconnaissance and road inventory survey was conducted to appreciate the topographical features and typical physical features along the project site. During the survey, a visual inspection of the condition of the pavement throughout the project stretch was also undertaken.

The subgrade soil samples were taken from 13 locations along the corridor of the project road. Laboratory evaluation comprising of Sieve analysis, Atterberg limits (liquid limit (W_l) and plastic limit (W_p)), Proctor Density test and California Bearing Ratio (CBR) test were carried out as per IS 2720 for soil classification, determination of maximum dry density and optimum moisture content and finally the CBR value of samples respectively.

Pavement Condition Survey was done for collecting the basic information of the road structure and based on this, the road could be demarcated into sections of more or less equal / uniform performance or sections of similar characteristics to obtain homogeneous sections.

Structural strength survey for existing pavement using Benkelman Beam Deflection Technique (BBD) was carried out. The deflection varies from 0.48mm to 1.53mm for the different sections.

Traffic characteristics of the study roads

Daily traffic along the Nelliparamba- Jaseela section was observed to be the highest and lowest along the Nadukani-Vazhikkadavu link. The daily traffic volume for other sections varied between 10,000 and 23,000 Passenger Car Units (PCU). It can be seen that the number of commercial vehicles were found to be more in Nelliparamba - Jaseela (3,089 commercial vehicles per day) whereas in Kacheripadi- Munduparamba, commercial vehicles per day was only 685 (**Figure 20**).

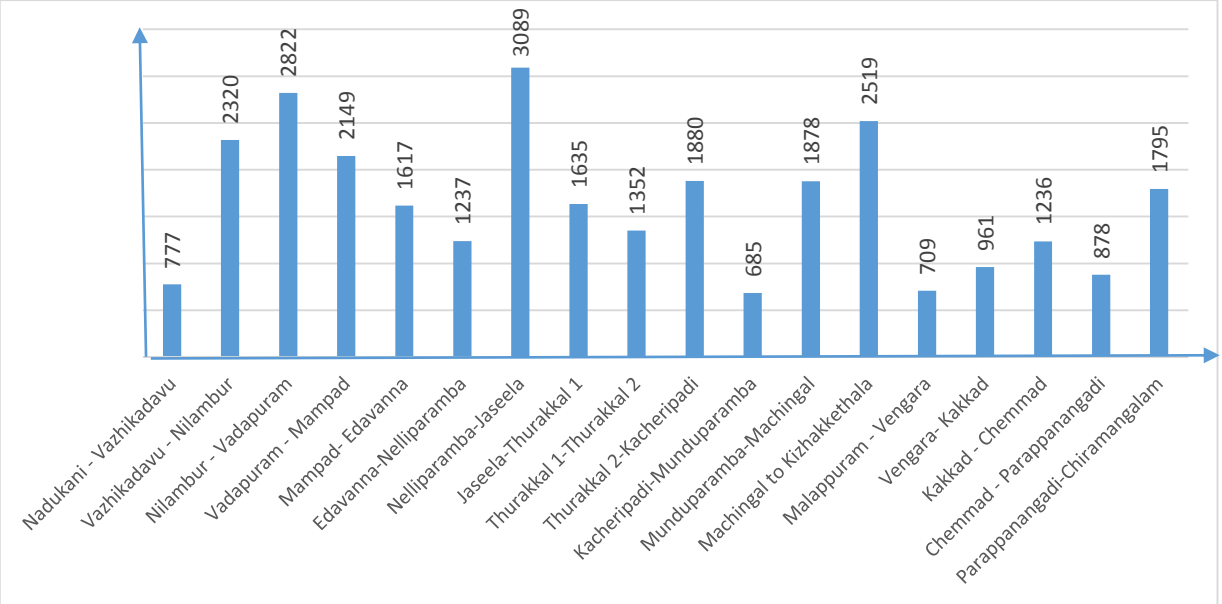


Figure 20: Commercial Vehicles per day

Pavement Rehabilitation

The section from Nadukani to Vazhikadavu has been proposed for reconstruction due to the proposed geometric correction along the section. Reconstruction has been proposed in Manjeri bypass section as the entire road section was found to be heavily distressed with severe cracking ranging from 20% to 65% and also with raveling ranging from 10% to 20% (**Table 9**). Also, the rebound deflection was around 1.6mm. The road section from Manjeri to Malappuram is also severely distressed with cracking and raveling, both in the range of 20% to 70%.

Table 9: Summary of the Distresses in Various Links

Sl. No.	Link	Cracking (%)	Ravelling (%)
1	Vazhikadavu-Nilambur	5 to 70	2 to 20
2	Nilambur-Vadapuram	5 to 40	5 to 10
3	Vadapuram-Mambad	10 to 70	5 to 20
4	Mambad-Manjeri	5 to 60	5 to 50
5	Manjeri Bypass	5 to 60	5 to 70
6	Manjeri-Malappuram	10 to 70	10 to 80
7	Malappuram Bypass	50 to 70	2 to 30

The design of overlays for the existing pavement has been carried out taking into account the traffic and strength of the existing pavement based on detailed pavement investigation including BBD testing.

The stretches identified for reconstruction were highly distressed with extensive cracking and raveling, and hence it was not desirable to overlay such surface. Overlay on these stretches will result in reflection cracking in due course of time and will increase the maintenance cost. Accordingly new pavement design has been suggested for those stretches.

21. Investigation and Design of Pavement of Purakkad- Pathirapally Stretch of NH 66 in Alappuzha District, Kerala

At the instance of Public Works Department, Government of Kerala, NATPAC worked out a rehabilitation strategy to the pavement of 22 kms long Purakkad – Pathirappilly section of National Highway 66 (NH 66) in Alappuzha District. As part of the study, tasks such as reconnaissance survey, pavement investigation, determination of subgrade soil properties, assessment of traffic volume, analysis of data and pavement design were carried out.

24-hour classified traffic volume data were collected from two locations and it was observed that a total of 7,793 commercial vehicles and 6,955 commercial vehicles were plying through Pathirapally and Ambalappuzha respectively on a normal working day.

Pavement cores were extracted from five locations along the stretch using Core Cutting Machine. Also, trial pits at the edge of carriageway were made for assessing the pavement composition and collecting the subgrade soil. Soil samples were taken from four locations and were analyzed in the laboratory. From the laboratory investigations, it is found that the subgrade soil is mostly sandy with different percentage of fines.

Plate 3: Seepage of water in base course

Plate 4: Deteriorated pavement at Kommady

Bitumen Extraction Test was conducted using Centrifuge Extractor by cold solvent extraction to determine the quantity of bitumen present in the existing pavement layers. Trichloroethylene was used as the solvent. It could be seen that, the bitumen content obtained for various bituminous layers in the study stretch was not found to comply even with the minimum desired.

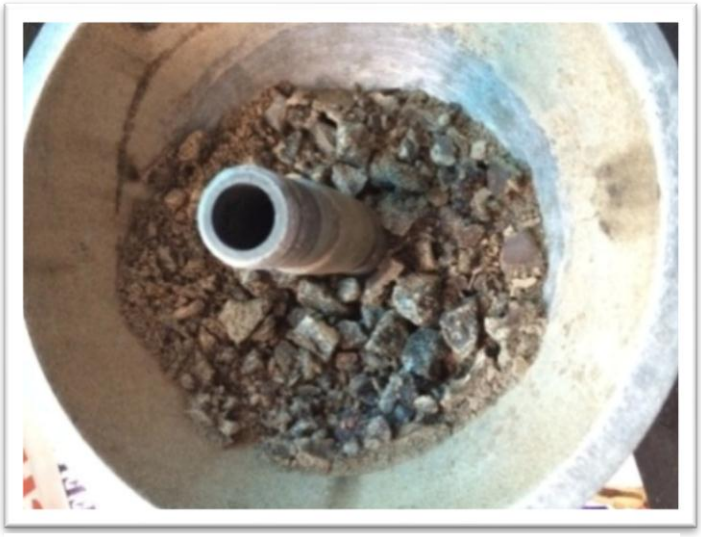


Plate 5: Extraction of bitumen using Centrifuge Extractor

Gradation was tested in order to determine whether the aggregates used in the various mixes obtained from core samples was properly graded or not. It was observed that the gradation of the aggregates does not comply with the specified values as per MoRTH.

Pavement Rehabilitation Strategy

As far as the Purakkad – Pathirappalli stretch is concerned, considering the stripping in the lower layers as evident from bitumen extraction test, and the mismatch between the gradation of the layers with the desired values, it is not advisable to overlay the existing pavement. Hence the section may be provided with new pavement layers starting from the sub-base layer. The existing pavement may be scarified and reused as Granular Sub Base (GSB) layer, provided the required gradation is achievable.

Figure 21: Design Thickness for new pavement

As 7,793 commercial vehicle ply along the corridor per day, design traffic has been worked out as 138 million standard axles (msa) for a design life of 15 years. Design thickness of different layers have been adopted from IRC 37-2012, corresponding to a California Bearing Ratio (CBR) of 9.2 % and design traffic of 138 msa.

22. Study on Conservation of Natural Resources by Recycling of Asphalt Pavements

Introduction

Reclaimed Asphalt Pavement is a recycling technique where there is reuse of the aggregates and binder which are milled out from the deteriorated pavements and mix it to the Hot Mix Asphalt (HMA) as aggregates in such a portion so that, the mix should get the required strength and performance. A study is being undertaken for determining the suitability of RAP in Kerala conditions as part of Plan project for the period 2016-17. The following objectives were set as part of the study

- To evaluate the performance of the mixes based on wheel rut test, indirect tensile strength test and moisture susceptibility test;
- To determine the Dynamic Modulus of RAP- HMA mixes using WITCZAK equation;
- To compute the stresses and strains of RAP-HMA mixes under field conditions, using the software KENPAVE.

Methodology adopted for the study

Methodology adopted for the study consisted of preparation of HMA mixes containing 30% RAP content with VG 10 and VG 30 binders and RAP (0%-20%)-HMA mixes with Natural Rubber Modified Bitumen (NRMB) for the surface course, performance evaluation of the prepared mix and performance evaluation using KENPAVE software.

Study findings

The Optimum Binder Content (%), Indirect Tensile Strength (dry and wet) and Tensile Strength Ratio of HMA-RAP mixes using NRMB with various percentages of RAP are tabulated in **Table 10**.

Table 10: ITS and TSR for RAP-HMA mixes using NRMB binder

RAP (R) and virgin aggregates (V)	OBC, (%)	ITS_{dry}, kPa	TSR
5% R +95% V	5.26	1988.019	88.3
10% R +90% V	5.10	2272.85	76.93
15% R +85% V	4.88	1689.523	94.9
20% R +80% V	4.80	1991.921	83.71
30% R +70% V	4.60	1320.79	67.35

The variation of Number of load repetitions for failure by rutting in msa with RAP percentage calculated from the 90 per cent reliability equation is plotted in **Figure 22**.

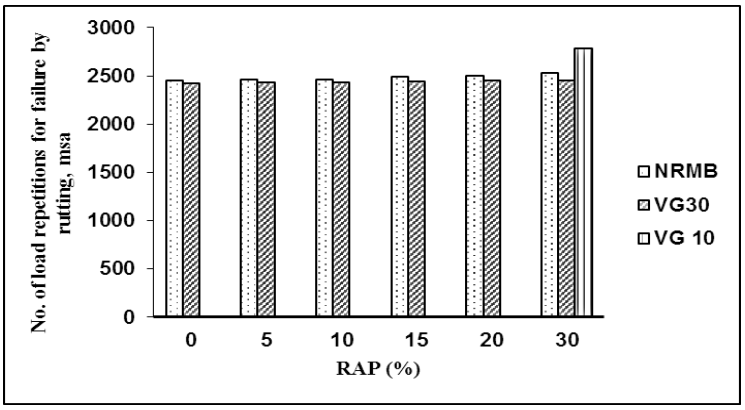


Figure 22: Number of load repetitions for failure by rutting for varying RAP %

Based on the laboratory tests, the following conclusions were drawn:

- The optimum binder content decreased with the increase in RAP content;
- More bitumen was required for mix prepared with bitumen of grade VG 10;
- With the addition of RAP, the ITS strength increased and rut decreased for both binders;

- Mixes with NRMB showed more resistance to rutting than VG 30 mixes;
- The TSR value decreased making the mix more susceptible to moisture damage so may be an anti-stripping agent needs to be used.

The performance evaluation of HMA-RAP mixes was evaluated using witczak predictive equation model and simulation using KENLAYER. The following conclusions were drawn.

- E value increases with the addition of RAP when both the binders are used;
- Number of load repetitions for the failure by rutting increased with increase in RAP percentages;
- When comparing VG30, NRMB and VG10 mixes, VG10 mixes with 30% RAP has higher resistances to rutting.

Need for further studies

More study needs to be conducted to arrive at suitable percentage of RAP which can be added as well as to understand the properties of RAP.

23. Use of Construction Waste Materials for Sub-base and Base layers of Flexible Pavements

Introduction

Nowadays, researchers have turned their attention towards the reuse/recycling of materials in all the sectors so as to minimize the resource depletion and to improve the environmental health. Research works are in progress for using waste materials such as copper slag, zinc slag, steel slag, pond ash, etc., in road construction. However, limited study has been done to use the construction zone waste materials in road construction, which is very limited in India. Appropriate management of construction waste would be greatly beneficial for our country as a whole. A study was undertaken by NATPAC as part of Plan Program for the year 2016-17 in the use of construction demolition waste material as a partial replacement in subbase layer.

The following objectives have been set for the study.

- Investigate the physical and strength characteristics of construction waste materials such as concrete blocks, solid concrete bricks and bricks;
- Study the feasibility of using the construction waste material as base and sub base layer in the pavement;

- Arrive at the gradation of demolished concrete waste to qualify for granular sub base (GSB) as per MoRTH specifications;
- Determine the effect of construction waste material proportion on the overall granular material for the sub base layers.

Methodology adopted for the study

The materials used for this study were concrete, hollow block and brick waste left over during construction and waste materials during demolition. Materials for lab work were collected from an old demolished building of age 20-25 years. Concrete waste, concrete blocks and bricks were separated from demolition waste materials and were crushed using a sledge and laboratory crusher. A series of tests such as Impact test, Abrasion test, Specific Gravity, Water absorption and shape tests was conducted on the crushed materials for determining the physical and engineering properties so as to be used as a replacement for virgin aggregates. The materials were then graded as per the 5th Revised MoRTH specifications for sub base layer. The materials were proportioned in the ratio of 60:20:20, 80:10:10 and 100:0:0 with the concrete waste, hollow block and brick waste respectively. A control mix was also prepared using virgin aggregates.

Study findings

The recycled sub base had a higher maximum dry density (MDD) and optimum moisture content (OMC) when compared to the MDD and OMC of the sub base prepared with natural materials. The mix proportion 100:0:0 were found most suitable as granular sub base (GSB) material than the other two proportions with higher brick waste content. The current mix proportion has achieved the necessary strength criteria however it fails to attain the permeability characteristics which is an important parameter of GSB.

24. Use of Waste Plastic in Sub-Grade Layer of Flexible Pavement

Introduction

The disposal of the plastic wastes without causing any ecological hazards has become a real challenge to the present society. Using plastic bottles as a soil stabilizer is an economical and gainful utilization since there is scarcity of good quality soil for embankments and fills. As an alternative method of disposal of plastic waste, shredded plastic can be added to the soil which will help in the improvement of bearing capacity of the poor soil. In this regard, NATPAC investigated the use of waste plastic materials in geotechnical applications and

evaluated the effects of shredded plastic fibers on shear strength of soil by carrying out direct shear tests and unconfined compression tests on two different soil samples.

The following objectives were set for the study

- To identify the optimum percentage of plastic fibres in soil by California Bearing Ratio Test;
- To evaluate the effects of the shredded plastic fibers on shear strength of soil by carrying out unconfined compression tests.

Methodology adopted for the study

Two types of soil namely clay soil and red soil were collected and their properties were examined for suitability for subgrade. Sets of CBR and UCC tests were carried out on soil and soil remolded with 0.1 % of shredded waste plastic of different sizes (600µ, 1.18mm, 2.36mm and 4.75mm) to understand the improvement in soil properties on addition of shredded plastic waste. Soil index properties and compaction characteristics were also found out.

600 micron ***1.18mm*** ***2.36mm*** ***4.75mm***

Plate 6: Sizes of Shredded plastic

Study findings

It was clear that mixing of shredded waste plastic fiber in soil subgrade can increase the strength of soil. The CBR value increased with the addition of shredded plastic but it further reduced with increase in size of shredded plastic waste. Unconfined compressive strength also increased with the addition of plastic waste to soil. CBR value and unconfined compressive strength increased when waste plastic fiber is added and is maximum for 1.18mm size beyond which the values decreased. This implies that benefits of reinforcement increases to certain level and after that it will decrease the strength.

25. Study on the Collapse Behavior of Compacted Soil in Highway Embankment

Introduction

Collapse is a major concern where compacted fills are found in civil engineering applications like highway embankments, earth dams, and other compacted fills. A study is being undertaken by NATPAC as part of the plan study for the year 2016-17 for determining the collapse potential of the soils. The following were the prime objectives of the study

- To identify whether the natural soil would be liable to collapse on saturation or not;
- To determine collapse potential at various placement conditions and under varying normal pressure.

Methodology adopted

Sets of single odometer tests were carried out in which the initial dry density, water content and the vertical stress at wetting were varied in turn to study the effect of placement conditions on collapse potential. The collapse potential for a single odometer test from the void ratio vertical stress plot **(Figure 23)** was determined as follows:

$$\mathrm{CP} = \frac{\Delta e}{1 + e_i}$$

where, e_i is the void ratio at the beginning of saturation and

Δe is the change in void ratio upon saturation.

Study findings

Two types of soils were selected for the work. The soils are silty sand (SM) and inorganic silt of medium plasticity (MI) **(Table 11)**. Thirty six set of odometer tests were performed to find the collapse behavior of MI and SM soils **(Table 12)**.

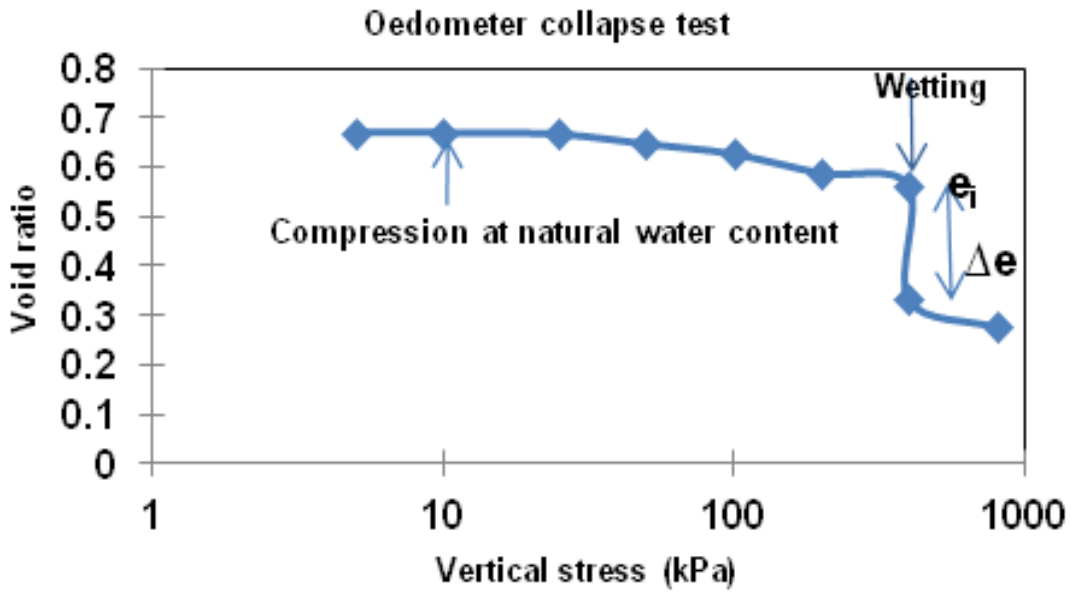


Figure 23: Determination of collapse potential

Table 11: Properties of Soils

Properties		**SM**	**MI**
Gravel (%)		6	19
Sand (%)		36	38
Silt (%)		35	29
Clay (%)		23	14
Liquid limit (%)		47	56
Plastic limit (%)		34	33
Plasticity index (%)		13	23
Specific gravity		2.59	2.55
Heavy compaction	OMC (%)	15.6	13.25
	MDD (g/cc)	1.725	1.854
Light compaction	OMC (%)	20	20
	MDD (g/cc)	1.56	1.694

The Compactive prestress of the compacted specimens decreased with increase in initial water content and increased with increase in dry density. Also the variation of Compactive prestress with dry density at higher water contents is minimal. The collapse potential of the compacted specimens decreased with increase in water content and dry density.

Table 12: Summary of collapse potential from odometer tests

Soil	Compaction condition		Collapse Potential (%)			Compactive stress (kPa)
	Dry Density(g/cc)	Water Content (%)	Vertical stress (kPa)			
			200	400	800	
MI	1.48 (80 % of MDD)	6	0.86	1.71	9.77	9000
		9	0.65	1.00	4.56	8305
		12	-0.92	0.48	3.09	4776
	1.68 (90 % of MDD)	6	0.75	1.35	8.62	11878
		9	0.15	0.37	4.08	10603
		12	-1.50	0.31	2.76	8243
SM	1.38 (80 % of MDD)	9	9.86	15.75	14.87	12940
		12	5.78	15.43	14.81	5687
		15.5	4.55	10.78	10.54	5813
	1.55 (90 % of MDD)	9	7.23	14.84	13.04	23369
		12	3.81	13.37	10.67	9115
		15.5	2.67	9.02	8.40	7026

In SM soil the collapse potential increased with increase in vertical stress and reached a maximum at critical stress of 400 kPa, beyond which it decreased. The reduction is due to the densification at higher stresses. MI soil exhibited swell at lower stresses due to the presence of more clay in the soil and required more vertical stress to collapse compared to SM soil.

26. Study on Failure of Roads in Kuttanad Region in Kerala State

Background

The Public Works Department, Government of Kerala requested NATPAC to study the damage caused to the roads in Kuttanad due to its topographical features and to formulate a strategy to develop long lasting pavements along the road stretches. In this regard, NATPAC conducted a detailed study about the Pavement structure by analyzing the soil and drainage characteristics in the selected road stretches of the Kuttanad region thereby suggesting suitable improvement schemes for a sustainable pavement.

Tasks carried out

As part of the study, reconnaissance survey was carried out in the identifying road stretches, followed by soil investigation (field and lab), traffic survey, pavement condition survey and investigation. Two types of soils - silty sand (SM) and inorganic silt of medium plasticity (MI) - were selected for the work.

Typical road stretch

Near bridge approach

Plate 7: Failure of road in Kuttanad region

Ambalapuzha–Thiruvalla Road

Alappuzha–Changanassery Road

Plate 8: Pavement layers of roads in Kuttanad region

Study findings

Along the road stretch, the subgrade soil was found to be silty sand (SM) and medium plastic silt (MI) even though the underlying soil is very soft clay. Also the soil forming the subgrade has CBR more than 8%. No shear failure was observed in the pavement due to differential settlement of soil. Since the entire stretch of road was founded on good subgrade soil over the soft clay, uniform settlement was observed except near the bridge approach as the bridge is

founded on piles. Summary of the laborary test results on subgrade soil samples are presented in **Table 13**.

Table 13: Summary of the laboratory test results on subgrade soil samples

Sl No.	Soil sample	Field CBR from DCPT (%)	Atterberg limits			Grain size distribution			
			W_l (%)	Wp (%)	Ip (%)	Gravel (%)	Sand (%)	Silt & Clay (%)	Soil Classification
1	KU1	14.3	50	34	16	11	43	47	SM
2	KU2	11.9	33	26	7	28	46	26	SM
3	KU3	11.17	30	22	8	22	55	23	SM
4	KU4	12.82	44	35	8	23	45	32	SM
5	KU5	15.72	47	34	13	30	39	31	SM
6	KU6	5.96	40	33	7	17	46	37	SM
7	KU7	9.56	43	29	14	35	39	26	SM
8	KU8	12.47	45	34	11	22	36	42	SM
9	KU9	22.43	40	31	9	27	34	39	SM
10	KU10	5.38	43	34	9	11	32	56	MI
11	KU11	23.42	40	33	8	19	48	34	SM

The pavement condition survey showed that most of the distresses were raveling, cracking and pot hole. The pavement layer details along with PWD data show that the wearing course was provided for most of the roads in PMC instead of structural layers and the GSB layer was missing in most cases. Pavement layer thickness of different road sections is given in **Table 14.**

Table 14: Pavement Layer Thickness of different Road Sections (mm)

Road Section	Sample	PMC/BC	Base	GSB	Old Pavement
Kidangara-Kannadi	KU 1	20	250	200	-
Alappuzha- Changanassery	KU 2	120	300	-	320
Pallikuttima- Pulinkunnu	KU 3	15	220	180	130
Kidangara-Kannadi	KU 4	25	-	330	-
Edathua- Mankompu	KU 5	50	-	140	-
Edathua- Mankompu	KU 6	20	-	170	-
Champakulam-Poopalli	KU 7	25	-	140	-
Kainakary- Poopally	KU 8	25	-	100	-
Kidangara-Chakulathukavu	KU 9	140	-	100	-
Ambalapuzha- Thiruvalla	KU 10	40	240	-	-
Thakazhi- Kunnumma	KU 11	25	-	130	-

27. Feasibility Study for the Development of Coastal Highway in Kerala

Background

Kerala coast line is passing through nine districts such as Thiruvananthapuram, Kollam, Alappuzha, Ernakulum, Thrissur, Malappuram, Kozhikode, Kannur and Kasargode and runs

for about 590km. At the instance of the Honorable Minister for Public Works and Registration, Government of Kerala, NATPAC is in the process of carrying out the feasibility study for developing the Coastal Highway from Thiruvananthapuram to Kasargode with minimum impact on the existing eco system. The main objective of the study was to assess the techno - economic feasibility of the identified Coastal Highway route with minimum impact on eco-system.

Methodology adopted for the study

The methodology adopted for the study consisted of reconnaissance survey, identification of alternative options, detailed road inventory study, traffic surveys, social and environmental impact assessment, preparation of cost estimate, evaluation of alternatives and economic and technical feasibility analysis.

Study outcome

For identifying the alignment, existing roads were utilized to the maximum extent and new roads were suggested at missing links. Wherever the alternatives are available, as an initial strategy, the routes were finalized by considering the following three factors.

1. Nearness to Sea
2. Least length of the Alternatives
3. Minimum number of buildings affected

Bridges were also proposed at many locations for ensuring the continuity of the alignment. Based on reconnaissance, possible links which could be developed as coastal highway were identified. Alternative options have been suggested for some stretches. It was recommended that 12m RoW with carriageway of 7m width can be adopted as a standard for the coastal highway. However, as per the local site conditions, the carriageway width and RoW can be limited to 5.5m and 8m, if the improvement necessitates large quantity of land acquisition/resettlements.

28. Prioritization of Hill Highway Sections for inclusion under Kerala Infrastructure Investment Fund Board (KIIFB)

The development of Hill Highway in Kerala starting from Nanadrapadavu in Kasargode district to Parasala in Thiruvananthapuram district has been a long standing demand. Considering the fact that, some of the portions of the Hill Highway are either developed

under specific schemes or are under development, NATPAC has been requested by the GoK to prioritise the sections en route. This will help in suitable allocation of funds and also will help in efficient implementation. Accordingly the development is envisioned through three Phases. Phase I aims at developing those stretches where land availability is ensured. Also, a provision for overlay has been included for those sections which are already in a developed and standard condition.

It is recommended that the Hill Highway be developed to standards of two lane road with 12 m Right-of-way (ROW) and 7m carriageway provided with paved shoulders and side drains. The Hill Highway has been conceptualized as a chain of existing roads including NHs, SHs, PWD roads and other roads including forest trails. This necessitates that development is warranted only for those sections not belonging to NHs and SHs. Also it has been seen that some of the sections have already been developed or is under development under various other schemes of the Government. Correspondingly the remaining sections have been recommended to be developed in three phases. It is estimated that a total of Rs. 3,316 Crores is required for developing Hill Highway so as to make it fully functional and operational.

29. Preparation of DPR for Hill Highway - Kannur and Kasargode Districts

Development of the proposed hill highway in Kerala State is expected to drastically reduce the distance from many production centres in the hilly regions to major market and commercial centres of the State. It will also improve the existing connectivity to many settlements especially for the tribal communities and will pave the way for greater integration of the marginal societies with the mainstream. Realizing the importance, Government of Kerala declared Hill Highway from Kadukkara in Thiruvananthapuram District to Nandarapadave in Kasargode District vide G.O. (RT.) No: 282/97 PW& T dated 3rd January 1997.

At the instance of Public Works Department, GoK, NATPAC prepared the DPR for the development of Hill Highway from Cherupuzha to Payyavoor in Kannur District and from Morathana to Idiyadukka in Kasargode District.

The tasks carried out for the study included inventory survey, classified Traffic Volume Count survey, topographic survey, geometric design, soil sample survey and testing, pavement design and cost estimate. Traffic data collected from the field were analyzed to obtain the existing traffic through the links and the service levels of intersections. The

pavement design was also carried out by using the deliverables from the laboratory tests. The DPR was prepared and submitted to PWD for implementation.

30. Design and Implementation of Road Safety and Traffic Management Schemes for Selected Road Stretches in Gurugram, Haryana State

Background

Maruti Suzuki India Limited (MSIL), a leading automobile manufacturer of the Country is undertaking several road safety initiatives in the country as part of Corporate Social Responsibility Scheme. As a continuum of the initiatives, MSIl wished to implement and evaluate a Safe Road Corridor Project in Gurugram, an emerging cyber city situated in National Capital Region (NCR) under the banner – "Sabhya Road Bhavya Gurugram". Under this project, it was planned to undertake the complete road safety transformation of three major road stretches in Gurugram. For undertaking a project of this kind, MSIL sought the services of National Transportation Planning and Research Centre (NATPAC), in providing necessary project guidance and technical assistance.

The objectives of the study were:

- To assess the overall crash scenario in the city and in-depth accident analysis of road condition, traffic flow etc. for three identified road corridors;
- To analyze the existing traffic and transportation problems of the identified corridors;
- To assess the road user behaviour and awareness level of traffic rules and regulations;
- To identify shortfalls in engineering, education, enforcement and emergency care and to suggest remedial measures;
- To evaluate the effectiveness of the various engineering schemes implemented and awareness campaigns conducted.

Considering the limitations in taking up the city as a whole, the scope of work was confined to four major road stretches.

1. Road from IFFCO Chowk to HUDA City centre
2. Road from HUDA city centre to Signature Tower
3. Road from Signature Tower to IFFCO Chowk

4. Road from IFFCO Chowk to Sikanderpur Metro Station

Methodology adopted for the study

Methodology adopted for the study is presented in **Figure 24** and explained as a set of tasks below;

- Reconnaissance and secondary data collection;
- Conduct of Primary Surveys;
- Identification of Accident black spots;
- Suggest improvement measures to solve engineering issues;
- Identification of focus areas and road safety issues;
- Design road safety awareness campaigns/ materials specifically to address the focus areas;
- Imparting road safety training to Traffic marshals;
- Conduct road safety awareness campaigns;
- Identification of enforcement issues and suggesting remedies;
- Identification of emergency care issues and suggesting remedies;
- Implementation of schemes - The proposals given by NATPAC was discussed with various stakeholders and officials. The schemes which got approval were implemented on the study corridor.

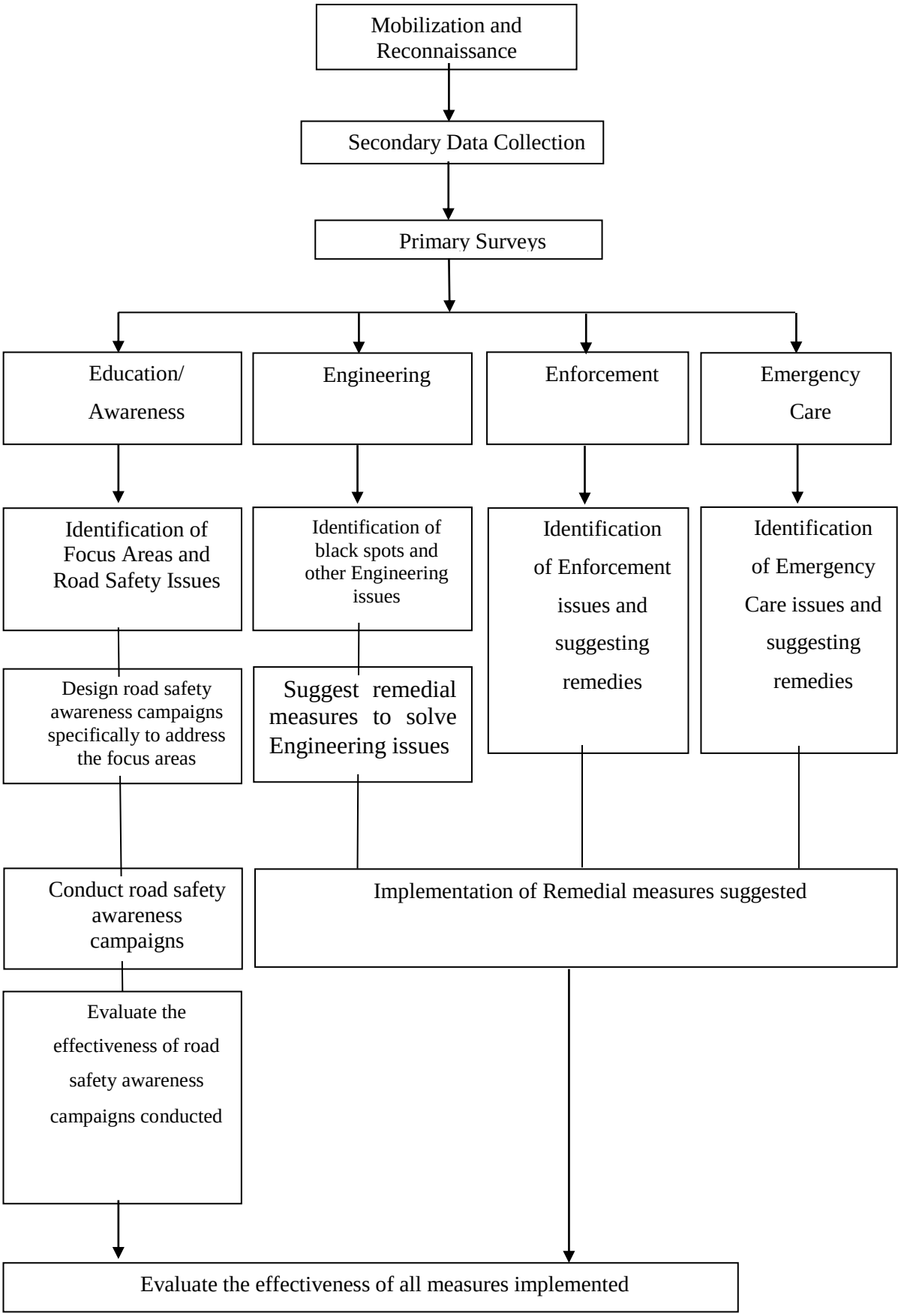


Figure 24: Methodology adopted for the Study

Study outcome

As part of the study, crash scenario of Gurugram city as well the study road were evaluated. Road safety improvement schemes were suggested for the study roads which included installation of road marking and signage scheme, junction improvement schemes, traffic management schemes at HUDA city centre etc. Road safety awareness programs were conducted among the school children, residential areas and general public. Road safety training was imparted to police personnel, traffic Marshalls etc. soft policing, pedestrian demonstration programs, road safety publicity campaign were also organized during the study period.

The proposed schemes were implemented on the ground by the Gurugram Municipal Corporation with funding by MSIL and overall supervision of NATPAC. A post evaluation of implemented schemes was made with the evaluation process depicted in **Figure 25**.

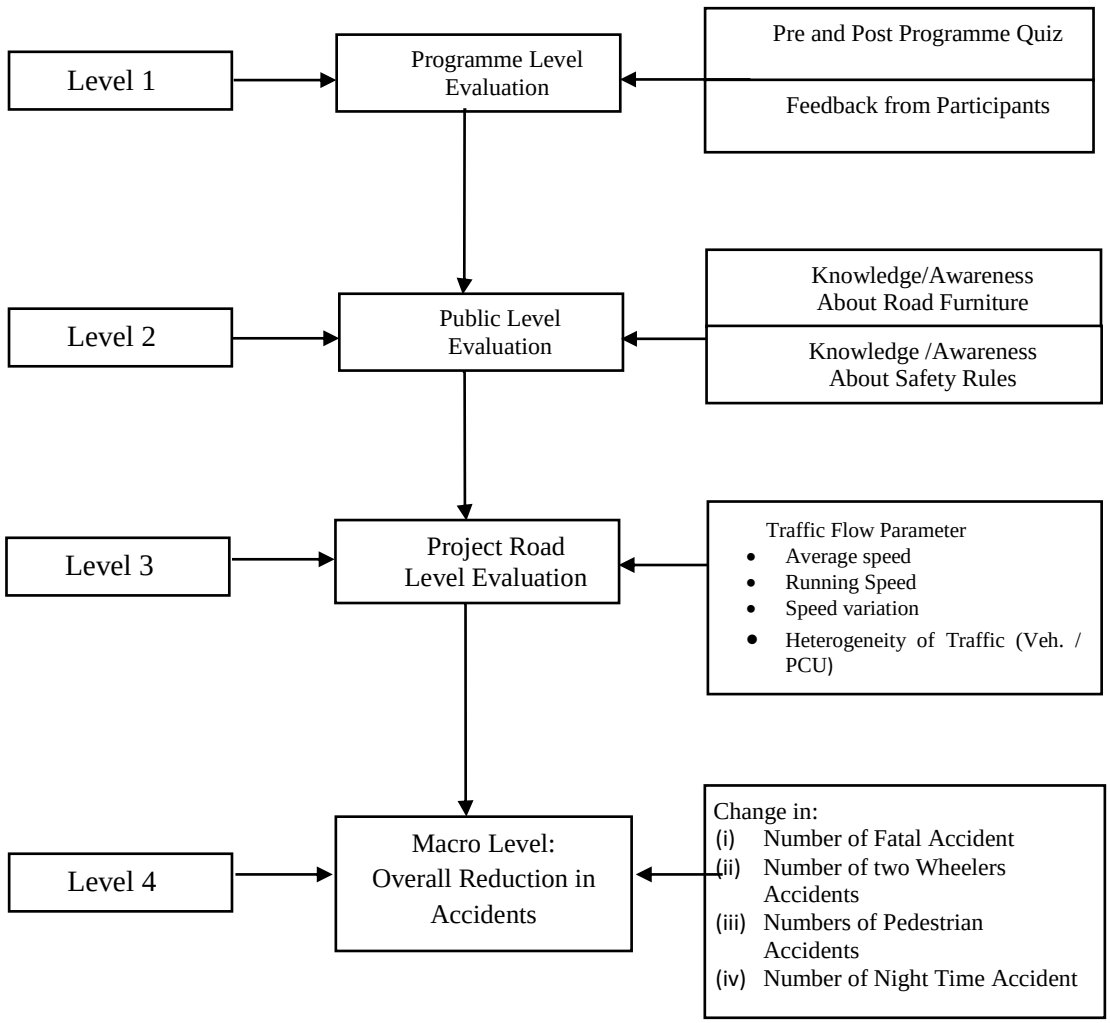


Figure 25: Multi level Evaluation Process

Crash scenario along the study stretch is found to have improved as shown in **Figure 26.**

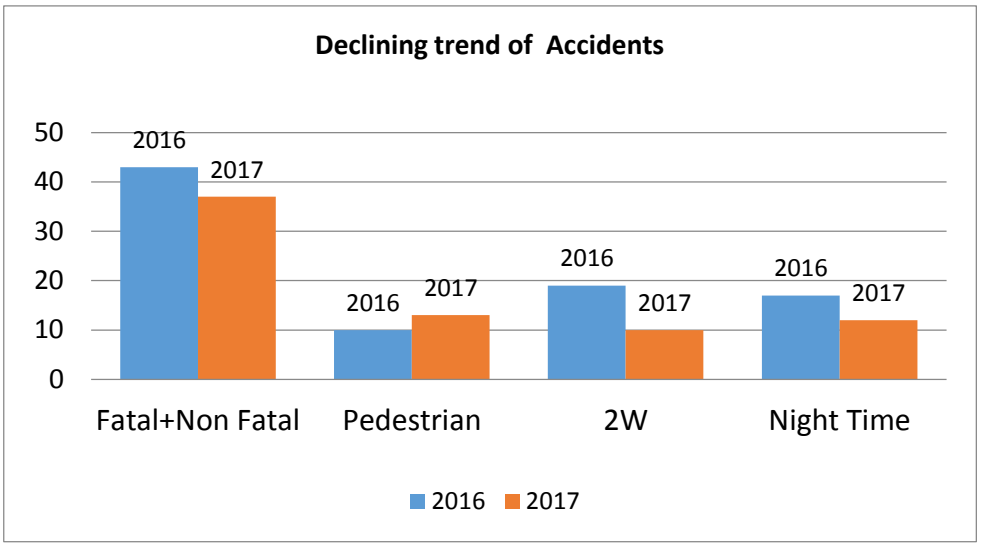


Figure 26: Trend of accidents

Values of road safety parameters have improved on the study stretch. The number of accidents per million km also improved to 1.39 in 2018 from 1.83 in 2016 **(Table 15)**.

Table 15: Overall accident trend on study stretch

Year	2014	2015	2016	2017	CAGR (from 2014-2017)	Change In percentage (2014-2017)
No. of accidents per 1,000 population	0.48	0.28	0.40	0.33	-0.12	-11.91
No. of accidents per 1,000 motor vehicle	1.00	0.55	0.77	0.62	-0.15	-14.78
No. of non-fatal accidents per 1,000 population	0.37	0.18	0.29	0.19	-0.20	-20.11
No. of persons killed per 1,000 vehicle	0.24	0.20	0.21	0.27	0.04	3.83
No. of persons injured per 1,000 vehicle	0.76	0.35	0.55	0.35	-0.23	-22.71

It is evaluated that initiatives undertaken by MSIl in association with NATPAC for this road safety project under the title "*Sabhya Road - Bhavya Gurugram*" had positive impact on road safety. Various activities like road safety education programmes, soft policing, installation of various road furniture etc. had salubrious impact on road safety.

31. Cost of Road Accidents in the State of Kerala

Introduction

Costing of road traffic accidents assumes importance due to the fact that road traffic accidents bring huge socio-economic burden on the society. It is widely accepted that road crashes account for 1-3% of the national Gross Domestic Product (GDP) in developing countries. In terms of public policy, governments need to justify the investment of tax-payer money for averting road accidents and also to understand the cost effectiveness of their policies. In this regard, NATPAC embarked on the task of costing of road accidents as part of their plan program for two years starting from the year 2016-17.

The main objectives of the study are:

- To understand the road accident scenario in the study area;
- To identify the major components, both tangible and intangible, affecting road accident cost;
- To device a methodology for comprehensive estimation of cost of accidents.

To study the cost of road accidents, Thiruvananthapuram district has been chosen covering urban as well as rural areas.

Methodology

The following tasks have been/ would be performed for realizing the above objectives:

i) Collection of the following data for the study area covering three years:-
   a. Accident data
   b. Details of victim(s), vehicle(s), property involved in crash from Police Station FIR
   c. Any other information that is available about the accident i.e., any other department/ agency assistance availed, hospital of treatment, legal status etc.

ii) Categorization of accidents into Fatal, Serious Injury and Minor Injury;

iii) Selection of sample of accidents (not exceeding 5%) for each category of accident, covering all possible components;

iv) For the sample accidents selected, the following would be conducted:-

a. Interview of victim(s) and/or family for getting direct and indirect expenses related to accident, including insurance benefits

b. Data from hospital/ clinic where the treatment was provided (actual cost would be arrived at after considering any subsidies availed) along with ambulance charges

c. Data from concerned Police officials, Fire & Rescue officials etc for details regarding manpower deployment and/or other equipments availed

d. Data from legal/ Motor Accident Claims Tribunal (MACT)/ Insurance company officials to get the legal and insurance expenses related to each accident.

v) Estimate the economic cost of accident by "gross output/ human capital" approach, including medical cost, cost of output loss, property damage costs etc.

vi) Estimate the Quality-adjusted Life Year (QALY) and thereby estimate the Comprehensive Total Crash cost.

Interim Findings of the study

Accident data for 2015 were collected and categorized into Fatal, Major, Minor and Property damage only cases. Sample size of 4.7% of victims was interviewed for medical cost, productivity loss, administrative cost and property damage. Data on Persons with disabilities collected by State Initiative on Disabilities and Social Justice Department showed that 30.2% of disabilities occurred due to accidents.

From the data compiled, it was observed that impact of accident on body parts was higher on lower limbs (46.2%), followed by upper limbs (27.2%), 19.4% on head and 7.2% on chest. **Table 16** shows the average cost of different types of accidents.

Table 16: Average accident cost

Sl No.	Cost Item			Injury/ Accident type			
				Fatal (0)	Major (69)	Minor (41)	Property Damage only (22)
1	Medical			-	1,22,714	2,838	-
2 (a)	Property damage			-	5,022	12,763	34,348
(b)	Loss of productivity due to PD			-	0	263	2,528
3	Days lost	Victim & By stander	Hospital	-	14 days	2 days	-
			Home	-	5 months	1 month	-
	Monthly Income	Victim		-	14,325	12,283	-
		By stander		-	6,963	5,100	-
	Output lost till date			-	92,577	8,833	-
Total				-	**2,20,312**	**24,695**	**36,875**

Status of work

Future work involves finding the procedures involved and manpower required for accident cases in hospitals, determine the vehicle category wise damaged parts and estimate the administrative cost due to accidents.

32. Evaluation of Functioning of Traffic Signal at Sri Mulam Club in Thiruvananthapuram City

Introduction

Vazhuthakkad Sree Mulam Club junction is a three arm junction located on Thykkad – Vellayambalam road in Thiruvananthapuram city. The third arm of the junction leads to Cotton Hill Girls High school, one of the largest schools in the city. To regulate the traffic flow through the junction, traffic signal has been installed. It is reported that in spite of functioning of traffic signal, huge delays are experienced for vehicles coming to Cotton Hill side. In the above background, City Police Chief requested NATPAC to study the functioning of the signal system and suggest corrective measures. Accordingly, NATPAC carried out site investigation and submitted an evaluation report on the traffic signal system

Site investigation

As per site investigation carried out at the junction, the following issues have been identified.

- The bell mouth of the junction on all the arms was narrow, resulting in long queue of vehicles
- Encroachments and location of bus stops also caused traffic hold up
- Unorganized parking found on RHS side of Vazhuthakkad- Sri Mulam Club stretch
- No pedestrian phase is provided at any of the arms
- Signal Jumping is observed and can lead to an accident. The signal jumping cases may reduce in future as the public will get used to the newly opened signal system at this junction
- During those days on which social functions are hosted at Trivandrum Club or Sri Mulam club, large numbers of trips are produced/attracted to these convention centres. The signal system will fail during that time in controlling the traffic efficiently
- If heavy congestion are experienced on MG road or blocking of MG road because of processions, traffic will be diverted to Vazhuthakkad Junction and will affect the smooth functioning of the signal system.

Suggestion for Improvement

A traffic signal synchronized with the signal system of Vazhuthakkad Junction is necessary for the traffic management at Sri-Mulam Club Junction. Manual control will not be effective in managing the queue on upstream of Thampanoor arm (Vazhuthakkad- Sri Mulam Club stretch). Modifications required for improving the efficiency of traffic system are listed below:

- All issues listed above shall be addressed to
- Footpath of minimum 1.8m should be ensured on Survey Directorate side of Cotton Hill Road
- A secondary signal head need to be provided for Cotton Hill arm near the corner of Survey Directorate
- Vazhuthakkad- Sri Mulam Club stretch need to be developed to standards 4-lane divided category. Footpath of 1.8m needs to be provided on this stretch

- Each lane of the road needs to be provided with standard road marking (directional arrows)
- Unorganized parking in the bell mouth area on all the intersecting arms need to be removed
- Strict enforcement has to be practiced for catching the traffic rule violation including Signal Jumping
- Signal System may be modified to ensure the following:
    i. Formation of queue on Cotton Hill arm during peak hours need to be avoided - Green time for Cotton Hill arm can be increased by 4 Sec.
    ii. Safe Pedestrian crossing need to ensure. Pedestrian phase should be included in the signal design.

33. Identification and Prioritization of Accident Black-Spots in Ernakulam District

Background

In Kerala, 117 persons were injured in road accidents per lakh population, which are nearly three times the national average and the highest in the country. During the year 2015 the state of Kerala ranked the highest (29,096) in the total number of persons grievously injured in the country. There is an urgent need to identify the black spots and prioritize them so that scarce resources can be utilized more judiciously for road safety measures. At the instance of Kerala Road Safety Authority, NATPAC has conducted study on identification and prioritization of accident black-spots in Ernakulam district, which has reported increased number of accidents.

Tasks performed as part of the study

The following tasks/services were carried out as part of the study:

- Collection and refinement of road accident data from Police department for a period of three years;
- Assessment of existing road accident scenario and trend in Ernakulam District;
- In-depth analysis of accident data to identify characteristics of road accidents;
- Identification of black-spot locations on the road stretches in Ernakulam District;
- Prioritization of hazardous locations for rectification through scientific methods on Geographic Information System (GIS);

- Visualization of accident spots on maps to highlight vulnerable locations in the district.

Study outcome

The road network and selected crash data were loaded in the ArcGIS software for identifying black spots. Each data points represent individual accidents of those locations which had recorded two or more road accidents involving fatal or grievous accidents during last three calendar years. Accident Severity Index (ASI) values of hazard prone stretches based on MoRTH's criteria were computed in ArcGIS software.

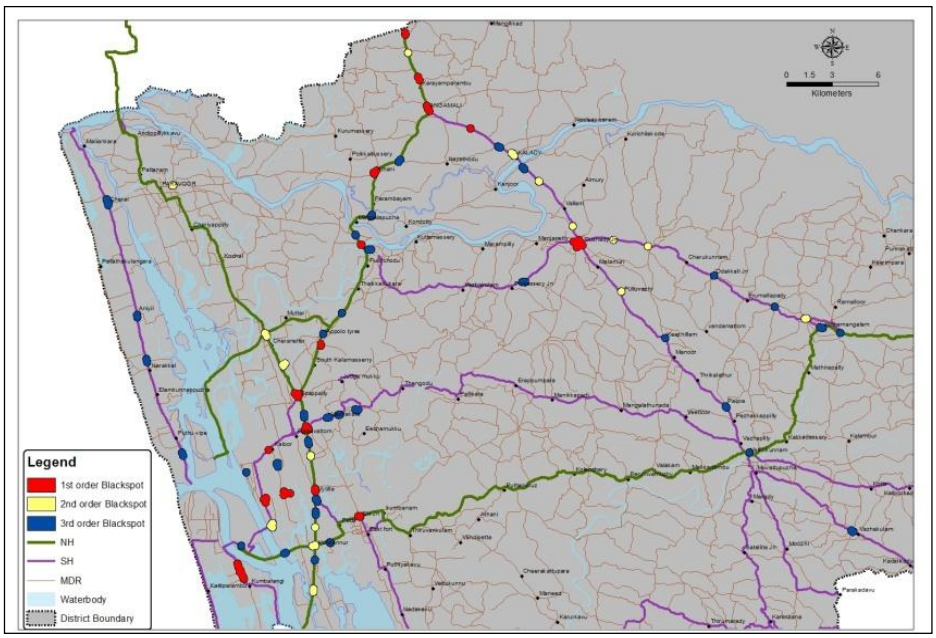


Figure 27:
Black Spots in Ernakulam District according to priority order

All hazardous stretches whose ASI value above threshold value of 178.03, were considered as first order black spots. The zones that are classified under first order black spots are highly accident prone, which should be given highest priority for implementing suitable counter measures. A total of 16 first order black spots have been identified.

ASI values of hazardous spots, which lie between 178.03 and 141.74, were considered as second order black spots. A total of 16 second order black spots have been identified, which should be rectified on second order priority basis. ASI values in between 141.74 and 105.44 were considered as third order black spots. A total of 35 third order black spots have been identified.

A total of 412 high risk locations have been identified in Ernakulam district. Of these 412 high risk locations, 67 locations have been identified as priority black spots. These identified black spots were prioritized into first order, second order and third order black spots for rectification. Deaths and injuries caused by road accidents are eminently preventable.

Effective coordination of road safety efforts across multiple sectors and stakeholders is critical for treatment of black spots.

34. Black Spot Determination of Traffic Accident Locations and its Spatial Association Characteristic Analysis based on Geographical Information System

Introduction

Geospatial technology in general and Geographical Information System (GIS) in particular has significant role in the analysis of accident black spots. The present study analyze the data regarding the accidents occurred in Kollam district by using Accident Severity Index (ASI) method suggested in NHAI (ToR), methodology proposed by MoRTH and GIS.

Tasks carried out

Three years accident details were collected on which the following tasks were carried out for the study:

- To apply Accident Severity Index (ASI) methodology proposed by MoRTH and NHAI to identify and prioritize accident prone locations and identify the most vulnerable accident stretch using accident data for the past three years;
- To conduct Road and Traffic survey in the most frequent accident occurring spots, mainly in National Highways in the study area;
- To analyze the road and traffic data on GIS platform to access the most vulnerable accident spots in the district;
- To identify various traffic and road related factors causing accident-prone spots and suggested remedial measures to prevent accidents in future.

Plate 9: Presence of Temple in Centre of Road – Madannada

Plate 10: Inadequate pedestrian facilities

Study outcome

There were 128 first order accident black spots, 77 second order, 98 third order and 226 fourth order accident spots identified in the district. A sample of 12% from the first order accident spots were taken up for detailed analysis. Most of the first order accident spots were located on the NH stretches. Of the total sample selected for the study, 13 locations are located on the NH and the remaining three are located on the other road stretches (**Table 17)**. Two NHs traverse through the district and the most vulnerable highway with regard to accidents is NH 66. As per the Road safety inspection performed on the above mentioned stretches, remedial measures to each individual spot were suggested.

Table 17: Accident Black Spot Locations

Place of Occurrence	Road Type	ASI	Priority (NHAI)	MoRTH Methodology
Puthiyakavu	NH	260	1st Order	Critical
Pallimukku	NH	225	1st Order	Critical
Chathannur	NH	223	1st Order	Critical
Vavakkavu	NH	213	1st Order	Critical
Perumpuzha	OR	204	1st Order	
Neendakara	NH	194	1st Order	Critical
Keralapuram	NH	193	1st Order	
Kalluvathukkal	NH	183	1st Order	
Ayathil	OR	176	1st Order	
Kavanad	NH	167	1st Order	
Bharanikkavu	OR	160	1st Order	
Paripally	NH	156	1st Order	
Kottiyam	NH	155	1st Order	
Karicodu	NH	153	1st Order	
Oachira	NH	150	1st Order	
Mukkada	NH	146	1st Order	

35. Operational Road Safety Audit from Varapuzha Bridge to Moothakunam Junction on National Highway - 66 in Ernakulam District

Background

Varapuzha - Moothakunam road stretch is part of NH-66 lying in Ernakulam district and is a high accident prone area characterized by inadequate carriageway width and sharp bends. At the instance of Public Works Department (NH), NATPAC has conducted Operational Road Safety Audit (O-RSA) to identify traffic hazards related to the road environment characteristics and propose interventions to mitigate the detected hazards. The total length of the study stretch from Varappuzha Bridge to Moothakunam Junction along the existing NH

alignment is 18.70km. Considering the one-way regulated roads and two Kottappuram bridges, the total length will be 21.8km.

The major objectives of the study are:

- To identify the accident-prone locations and potential road safety hazards on the study stretch;
- To suggest short-term improvement measures which can be implemented within one to two months;
- To furnish indicative drawings/sketches along with cost estimate.

Tasks carried out

As part of the study, the following tasks were carried out;

- Reconnaissance survey;
- Collection of accident data;
- Skid resistance test;
- Spot speed survey;
- Traffic surveys;
- Identification of current and potential safety problems;
- Short term schemes for improving the road safety and
- Cost estimate for implementation of the proposed schemes.

Site appreciation

Skid resistance test were conducted at Varapuzha Bridge using Portable Skid Resistance Tester at different locations intermittently using wet and dry conditions. Considering the worse scenario of wet pavement surface, average skid resistance value obtained was 35.67, which was found to be below the permissible level in comparison with suggested minimum values of skid resistance as per ASTM E303 - 93(2013). Application of coarse quarry dust with heavy rolling of pavement surface is recommended to enhance skid resistance, thereby less prone to skidding.

Spot speed survey was carried out at various locations on the narrow road stretch from Varapuzha to Moothakunam with the help of speed radar. The overall average spot speed in the study stretch was found to be 40.8 kmph and the 85^{th} percentile speed was found to be 49.3kmph.

It is found that Shappupadi Junction witnessed the highest peak hour traffic flow of 3,761 PCU, followed by 3,610 PCU at KMK Jn and 3,122 PCU at SNDP Junction. At Cheriyapally Junction and Moothakunnam junction, the peak hour traffic flow varied between 2,000 to 2,500 PCU. Others junctions handled peak hour traffic flow above 2,500 PCU. Link volume survey was carried out at Varapuzha Bridge and Moothakunam - Kottappuram Bridge sections. Varapuzha bridge section and Moothakunam - Kottappuram bridge section recorded daily traffic of 35,489 PCU and 33,247 PCU respectively. From the Volume/Capacity ratio analysis, it has been found that study road stretch on NH-66 is operating at more than twice their design capacity.

The study road bear the significant traffic movements but has inadequate width of carriageway, sharp curves and a number of access roads on either sides of NH close to vulnerable locations such as bus stops, curves, bridges etc. Geometric deficiencies exists at these stretches due to the presence of number of reverse curves and single curves having insufficient radius and lack of sight distance due to the buildings and compound walls projecting on to the road. Non-compliance to posted speed limits and no-overtaking sections, heavy vehicle movement along the narrow highway, hazardous overtaking by bus drivers, etc further risk the life of road users on the study stretch from Varapuzha to Moothakunam.

Proposed improvements

Class C - Type XI Prismatic Grade sheeting conforming to IRC standards has to be practiced for the signs. Pavement markings and road studs in Kottappuram - Varapuzha road section and on side access roads should be marked as normal section for 1.05 kms, as warning section for 14.62 kms and asno-overtaking section for 16.53 kms.

Speed restriction measures on National highway stretch should be provided in the form of Thermoplastic Bar marking, rumble strips, Speed radar cameras with ANPR technology, Vehicle activated speed limit signs, Speed limit LED blinker light, etc. All side roads on to National Highway should be provided with speed breakers complying to IRC norms accompanied by marking and advance sign.

It is proposed to provide adequate pedestrian facilities and minimum zebra crossing width of 2m at requisite locations. It is suggested to relocate bus stops as short-term measure and bus bays shall be constructed as medium term measure. Bus stop near SNDP junction shall be shifted to additional lane provided at Varapuzha Toll and will act as bus bay.

Speed cameras with point-to-point enforcement system should be installed for both directions on the straight sections on Varapuzha Bridge, SNDP Junction - Shappupady Section, Kavilnada - Kochal Junction and Moothakunam - Kottappuram bridge section. It is recommended to install surveillance cameras at 28 priority locations along the road stretch from Moothakunam to Varapuzha.

Cost estimate

It is estimated that a total cost of Rs. 10.46 crores will be required for implementation of short term road safety proposals in the study stretch.

36. Mitigative Measures for Reducing Pedestrian Related Accidents in Selected Urban Roads in Kerala

Introduction

NATPAC identified the most hazardous stretch for pedestrians in Thiruvananthapuram city, based on accident data. The research intends to develop accident predictive models for pedestrians that would describe the expected number of accidents at selected road stretches and also to propose countermeasures for the safety of the pedestrians.

The objectives of the study are:

- To identify road stretch in Thiruvananthapuram City having highest number of pedestrian accidents;
- To identify roadway and traffic parameters affecting safety of pedestrians in the selected road stretch;
- To develop suitable models for predicting pedestrian accidents at a particular road section;
- To propose recommendations for enhancing pedestrian safety on the selected road stretch.

Methodology adopted for the study

Methodology adopted for the study consisted of collection of accident data of Thiruvananthapuram City from Traffic Police, identification of study stretch, primary data collection, development of accident prediction models, model validation, interpretation of results and proposal of pedestrian safety enhancement strategies. The primary data collected include the road inventory, inventory of pedestrian walking and crossing facilities, inventory

of roadside features, traffic and pedestrian volume, speed of vehicles and adjoining predominant land use.

Study findings

It has been found that even though NH-66 passing through the city have fairly better pedestrian facilities, a greater percentage of pedestrian accidents occur along this stretch. Urban road section from Ulloor to Karamana has recorded highest pedestrian accidents per km length. Hence the study stretch was selected as starting from Ulloor to Karamana along NH-66 and having a total length of 9.5 km.

Among the Generalized Linear Models developed using SPSS software, poisson regression model provided better fit. The models were found to be valid only if all the parameters used in the model were significant at 5% level of significance. The final models which satisfied all the statistical tests are given in **Table 18.**

Table 18: Pedestrian Accident Prediction Models Developed

Accident Type	Model
Total accidents	$TOA = e^{(-5.530+0.304NOB+0.193S+0.000608PCUph - 0.268NCQA+0.000133PVF)}$
Grievous accidents	$GI = e^{(-1.924+0.525NOB +0.000679PCUph+0.232ISR)}$
Minor accidents	$MI = e^{(-7.099+0.299S+0.000348PVC-0.348NCQA)}$
Fatal accidents	$FI = e^{(-17.308+0.695S-0.989NSC)}$
Combined fatal and grievous injury accidents	$FGI = e^{(-2.652+0.408*NOB +0.146*S+0.172*NOZU +0.000084*PVF)}$

The parameters mentioned in the model are:

TOA = Total number of pedestrian accidents,

GI = Number of grievous injury accidents,

MI = Number of minor injury accidents,

FI = Number of fatal injury accidents,

FGI = Number of combined fatal and grievous injury accidents,

NOB = Bus stop density/500m, S = Speed of vehicles in km/hr,

PCUph = Total number of vehicles in PCU/hr,

NCQA = Number of crossings whose quality is adequate,

PVF = Peak hour Lateral Pedestrian volume,

ISR = Intermediate Side Roads,

PVC = Pedestrian Cross Volume,

NSC = Number of signalized crossing,

NOZU = Number of pedestrian crossings where U-turn is possible.

Models were developed for predicting total pedestrian accidents and severity levels -grievous, minor & fatal. It was found that Poisson regression models were found to be best fitting. Validation of the models proved that it could be further used for predicting pedestrian accidents in urban midblock sections. Bus stop density, vehicle speed, peak hour traffic volume and pedestrian volume, density of access roads, signalized crossings and quality of crossings proved to be significant factors contributing in pedestrian crashes.

37. Traffic Training Park at Kasargode City

Background

Kasargode Regional Transport Office has decided to construct a traffic park in the land available near RTO, Kasargode. In this regard, Kasargode RTO requested NATPAC to design the traffic park in Kasargode district which can help to provide traffic education to children.

Proposed design for the Traffic Park

Two options were considered in this study. One with Pedal Powered Toy cars and Traffic Park for normal vehicles. The options are as follows.

Option 1: Traffic Park for Pedal Powered (Toy) Cars: The Park features miniature streets and footpaths which were created along the traffic signals and road sign boards. This may help children to navigate in the streets and operate according to traffic laws. The park is designed as the miniature of the present traffic scenario which provides traffic related knowledge like sign boards, signals, traffic rules etc. to the park users. The traffic park can be considered as green zones which include mini versions of T intersections, roundabouts, four arm intersections, one-way etc. Proper turning radius is provided at the curves for the smooth turning of the vehicles. The location of duly marked traffic sign boards are also shown in the Option 1 which have to be followed for the safe movement in the park. The facilities in the traffic park are provided within the available land area. Recreation ground and play grounds are also accommodated within the proposed land limits. Children are allowed with small bicycles or pedal-powered cars. Films/slide shows related to road safety can also be shown to children. The park also showcases the Zebra/ pedestrian crossing lines along with large traffic

symbols displayed on a board. Children's Park is also included in the traffic park premises for the entertainment of the children

Option 2: Traffic Park for Normal Vehicles: Option of the traffic park consists of roads, footpath, roundabouts and channelizers which are designed for normal vehicles. This helps adults to drive in the roads obeying traffic rules. The park is designed as the miniature of the present traffic scenario which provides traffic related knowledge like sign boards, signals, traffic rules etc. The traffic park includes roundabouts, one-way, left hand and right hand curves etc. A turning radius of 12 m is provided at the curves for the smooth turning of the vehicles. Road markings indicating directions, stop lines, zebra crossings are given at required locations. The location of duly marked traffic sign boards are also shown in the Option 2 which have to be followed for the safe movement in the park. For the construction of Traffic Park for normal vehicles, more than 2 acre land is required to provide all the adequate facilities. Since the land proposed for the traffic park near Kasargode RTO is less than 2 acre, the park facilities have to be limited to the available land.

Recommended option: The traffic park is considered as a good medium for educating the kids and youth about the traffic rules and creating awareness in them. Option 1 is proposed for kids and option 2 for adults. It is seen that nowadays children are also the victims of road accidents. This situation can be avoided by providing proper awareness about traffic rules and guiding them to the right path. Although Option 1 and Option 2 are beneficial, Option 1 is more preferable considering the safety of younger generation.

38. Road Safety Improvement Study on various Road Stretches in Kanjirappally in Kottayam District, Kerala

Background

Kalathipady – Mundakayam (49.3km) road stretch on NH-183, Ponkunnam – Manjakuzhy (6.45km) stretch on SH-8, 26th mile – Koovapally road (3.8km) and Makkal kavala – Kanamala (2.3km) on SH-44 and Perumanoorkulam junction on Manarcaud – Thiruvanchoor road under the Kanjirappally Police jurisdiction of Kottayam District were found to be accident prone locations as per accident statistics compiled by Police. In this regard, Deputy Superintend of Police, Kanjirappally, requested NATPAC to conduct a road safety inspection at these locations, identify potential road safety hazards, and suggest short-term and long-term improvement measures.

Tasks carried out

NATPAC team carried out site appreciation and reconnaissance survey, collected of accident data pertaining to the study stretch, identified current and potential safety problems using relevant IRC standards and checklists, assessed the shortcomings in the existing facilities, evolved short term and long term schemes for improving the road safety and estimated indicative cost for implementation of the proposed schemes.

Study findings

The road stretches under consideration had significant traffic movements and there exists a number of vulnerable locations such as curves, bridges etc. As the vehicles from the access roads enter the NH and merge with the fast moving vehicles, there is a high probability of accident occurrence. Poor retro-reflective signs, less visible markings, lack of retro-reflective studs, absence of street lighting, unscientific design of intersections and bus stops etc. add to the woes. Behavior of drivers lacking road discipline and defensive techniques makes road users more vulnerable to accidents.

Plate 11
Curve Approach in PP Road

Plate 12
2nd Mile junction

Study recommendations

As a short term measure, the sharp curves were suggested to be provided with the corresponding speed limit boards, as in NH 183. Additional safety provisions such as installation of chevron boards in curves, removal of vegetation on both road sides which affect the sight distance and other speed control measures were suggested.

The short-term measures recommended to be adopted to improve safety of all categories of road users were improvement of junctions and road stretches, installation of road signs,

provision of road markings and studs, speed reducing measures, improvement of pedestrian facilities, street lighting, public transport facilities, road features, routine maintenance of infrastructure, parking management measures, traffic management measures, enforcement measures and road safety awareness, education and training. The following steps were recommended for reducing accidents on all the study stretches:

- Engineering treatments and traffic control techniques to improve safety and walkability of road stretches;
- Enhancement of visibility on the entire road stretch, which is hampered by obstructions such as vegetation, low set back distance, inadequate flaring of intersections, presence of hoardings/advertisements etc.;
- Inspection and maintenance of traffic safety devices at regular intervals;
- Effective coordination between concerned departments for successful implementation of remedial measures.

Cost estimate for improvement schemes

It is estimated that a total cost of **Rs. 28.00 Lakhs** will be required for Ponkunnam – Manjakuzhy road stretch, **Rs. 3.00 Crores** for NH 183 stretch and **Rs. 30.00 Lakhs** for the road stretch from 26th mile – Koovapally and Makkal kavala to Kanamala for implementation of short term road safety proposals.

39. Level of Compliance of Seat Belt Usage in Selected Cities of Kerala

Background

Use of seat belt is found to have reduced accident severity in many accident crashes and Government is making sincere efforts to encourage people to use them in their own interest. However, the usage of seat belt among the car users is not at the desired level which warrants steps to identify factors for non-usage and evolve measures to encourage them. In this regard, NATPAC carried out an investigative study to identify various factors related to seat belt usage among car occupants using different perspectives and methods, and to evolve suitable interventions for increasing seat belt use rates.

Methodology adopted for the study

Methodology adopted for the study is presented as a flow chart in **Figure 28**.

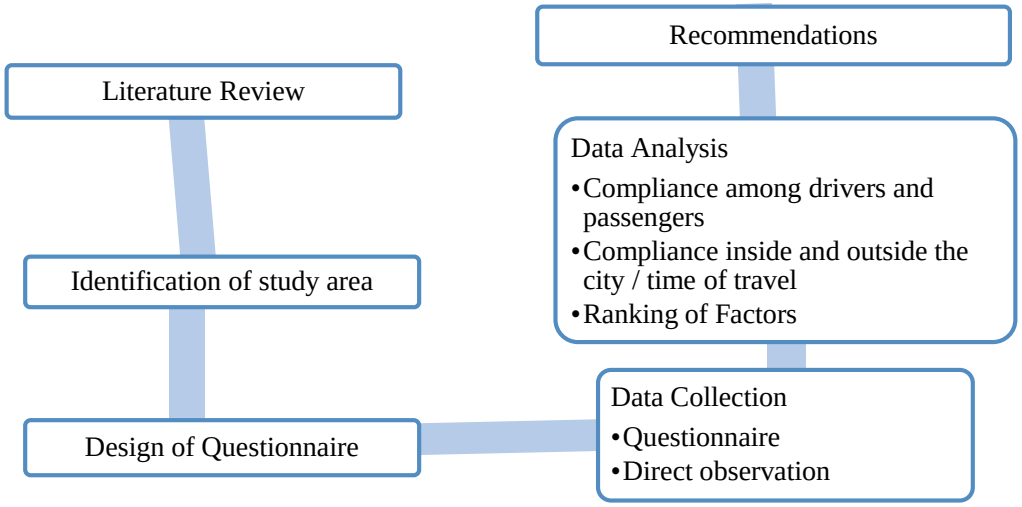


Figure 28: Methodology

The data for the present study was collected from three different districts in Kerala viz. Thiruvananthapuram, Pathanamthitta and Kottayam. They were selected in such a way that it would represent the urban, semi urban and rural characteristics. Questionnaire survey was conducted in all the three districts which included the demographic, environmental and psycho-social factors. Demographic factors included age, gender, education, occupation, etc. Environmental factors included the time of wearing seat belt, location of wearing seat belt, etc. Psycho-social factors included the use of seat belt while sitting in the front seat or rear seat, etc.

Observation survey was also conducted in all the three districts in which data collected included details like age, gender and seat belt usage while sitting in the front seat and rear seat.

Study findings

It could be inferred from the study that the seat belt compliance level of drivers is more in Thiruvananthapuram than in Pathanamthitta and Kottayam. Drivers are found to be keeping more compliance than front seat passengers and rear seat passengers. Compared to places outside the city people were found to use seat belts inside the city. People in all the three districts have considered distance as an important factor in usage of seat belt. Compared to day time, the usage of seat belt is very less during night driving.

In the questionnaire survey, people were asked to rank the different positives and negatives in wearing a seat belt. Most people believe that they are likely to get trapped in the car in case of an accident if they use the seat belt and they are also under the wrong notion that the airbags will protect them even without a seat belt in case of an emergency. The major positive thing in wearing a seat belt, according to them, is that it increases the confidence in driving and that it prevents people from being thrown out from the vehicle in case of accidents.

40. Impact of Road Safety Initiatives in Thiruvananthapuram city

Background

A large number of road safety initiatives have been made in Thiruvananthapuram which take the form of road widening, junction design, road signs and marking, installation of ITS applications etc. NATPAC has made an attempt to assess user's satisfaction and expectation level on the road safety initiatives that have been implemented in the city**.** The one kilometer stretch of MG Road between Overbridge to Attakulangara in Thiruvananthapuram city, Kerala was selected as the study corridor which is also a major CBD area of the city. This area is severely congested due to heavy vehicular and pedestrian movement which makes it one of the major accident prone stretches in the city.

Tasks carried out

The centre, as part of the study, evaluated the current traffic scenario by conducting limited traffic and road inventory surveys thereby creating baseline data on geometrical details, traffic volume, pedestrian flow, parking demand etc of the study area. User satisfaction score has been developed as the next stage of the study by interviewing road users through questionnaires.

A five-point scale of rating was used to rate user's satisfaction level based on various parameters. On this scale, the respondent can rate his/her opinion between one and five, where five being the highest level, indicates that the respondent is highly satisfied with the new improvements in the study area. The classification of weightage on various parameters used in this study are given in **Table 19.**

Table 19: Summary of parameter, key factors and weightage

Parameters	Components	Weightage
Safety	Safety aspects	25
Pedestrian Crossings		
Guard rails/Other safety features		
Street light		
Traffic signals		
Congestion	Comfort & Convenience	20
Footpath height & Width		
Median height & Width		
Road Width		
Accessibility to settlements	Value for time and money	10
Effect on time taken		
Pavement marking & Delineation	Road markings& signs	15
Adequacy &visibility		
Appearance	Road Condition	15
Drainage facility		
Surface quality		
Maintenance		
Parking	Parking facility	15
SATISFACTION SCORE		**100**

Study findings

In the study area, two-wheelers constituted the major traffic flow (51.13%) followed by passenger Auto rickshaws (34.2%), car/van/jeep (10%), Buses (3.96%) etc. The highest peak on-street parking accumulation within the study stretch was between over bridge and Mele-Pazhavangadi area consisting mostly of two wheelers and cars. This is one of the new authorized areas for on-street parking in the stretch. Heavy peak hour lateral movements of 1,509 was observed between Pazhavangadi - East fort (Chalai deviation), followed by 1,303 between Mele Pazhavangadi -Pazhavangadi section. Similarly, Mele Pazhavangadi - Pazhavangadi and Pazhavangadi - East fort area were having high cross pedestrian movements.

Road user satisfaction level of various parameters computed for the three road segments have been worked out as given in **Table 20.**

Table 20: Summary of parameter, key factors and weightage

Key factors	Attakulangara	Overbridge	Pazhavangadi
Road Condition	3.35	3.68	3.75
Comfort & Convenience	3.35	3.71	3.77
Value of time and money	3.39	3.67	3.57
Safety aspects	3.25	3.53	3.38
Road signs& marking	3.42	3.80	3.86
Parking facility	2.92	2.71	3.06
Overall satisfaction scores	**3.28**	**3.52**	**3.56**

Satisfaction levels were high in Pazhavangadi area and low in Attakulangara. This is primarily because of the several improvements implemented here in the past two years such as road widening, renovation of bus stand, beautification of roads, overall maintenance etc. Pedestrian crossing is still an issue in the study area. People need to wait for a long time to cross the roads safely especially at Pazhavangadi area.

The study also maintains a database of the traffic scenario and other geometrical details of the entire stretch. This data can be used as a baseline data for conducting further developments and other safety initiative works on these areas. Moreover, it was found that initiatives taken by various government agencies resulted in better safety level on these roads.

41. Helmet and Seatbelt Usage Survey in Thiruvananthapuram City

Background

Government of Kerala has availed a loan from the International Bank for Reconstruction and Development (IBRD) for implementing a road infrastructure project under the Kerala State Transport Project (KSTP) II. As part of this loan, GoK has taken up a Safety Corridor Demonstration Program (SCDP), focusing a high-risk corridor on a pilot basis to achieve targeted road safety results. Also, the GoK intends to apply a portion of this loan to assess the extent of helmet and seat belt usage among road users and plan road safety campaign in the future. This could be used as a benchmark to assess the effectiveness of future interventions targeting helmet use. In this regard, at the instance of KSTP, NATPAC conducted a pilot survey of helmet wearing and seatbelt usage by car drivers and passengers at selected six locations in Thiruvananthapuram city.

Tasks carried out as part of the study

Helmet Usage survey: Observational survey was conducted at the six selected locations on weekdays and Sundays with a minimum of 1,000 samples, out of which 500 samples were taken during day time and 500 at night. A detailed database was generated from the observation survey which included information on helmet user (rider/pillion, child), type of motorcycle (geared/gearless), use of chin strap, person type, level of enforcement, helmet usage during day and night etc. at selected locations. The data analysis was done to determine the helmet wearing rates by considering most of the factors mentioned above in the multivariate level.

Seat belt Usage survey: NATPAC conducted an observational survey to assess the characteristics of existing seatbelt usage in Thiruvananthapuram. For identifying the locations, a mixture of urban and rural roads with varying cases of speed limits, type of road, level of enforcement and variety of road users were selected. The observational survey was conducted at six selected locations in weekdays and Sunday with a minimum of 1,000 samples of which 500 samples were taken during day time and 500 at night. A detailed database was generated from the observation survey which included information of seatbelt usage by driver/passenger, seating capacity of vehicle, age of the vehicle, level of enforcement, time of observation, etc. at selected locations. The data were analyzed to determine the seatbelt usage rates by considering most of the factors mentioned above in the multivariate level.

Study findings on helmet usage

A total of 36,192 motor cycle samples including 19,212 during the weekdays and 16,980 samples on Sundays from the selected six locations were taken. The overall results show that only 65% of riders and 1% of pillion riders wore helmet in Thiruvananthapuram City. The helmet wearing rates among riders of Geared motorcycles (66%) were more than that of gearless riders (637%). Similarly, the helmet wearing rates among pillion riders of geared motorcycles (2%) were more than that of gearless motorcycles (1%). Regarding the correct use of motorcycle helmet, it was found that more than half (52%) wore the helmet correctly with tightened strap. Three in ten riders (30%) wore helmet with loosed strap and about one in five riders (19%) did not fasten chin strap. Helmet usage among male and female at the different survey locations is shown in **Figure 29**.

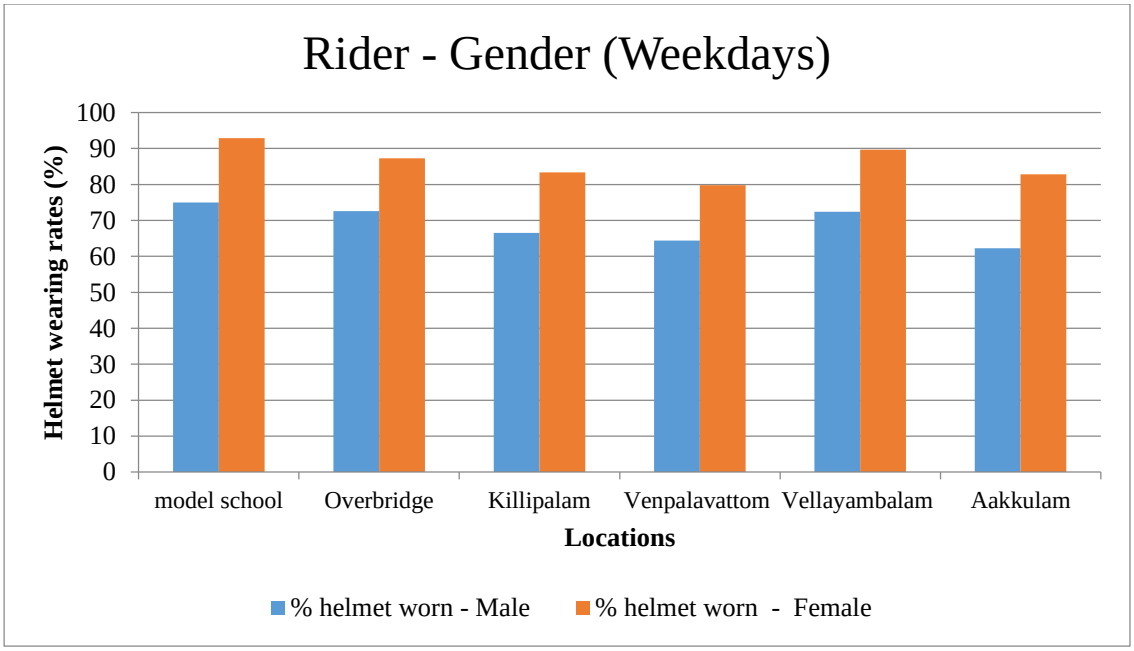


Figure 29: Rider helmet wearing rates during Weekdays (Gender-wise)

Study findings on Seatbelt usage

A total of 37,286 car samples including 20,574 samples during the weekdays and 16,712 samples on Sundays were observed from the selected six locations. The overall results show that out of 37,286 drivers observed, only 77% of drivers wore a seat belt. Out of 18,481 front seat passengers observed, only 16%) wore a seat belt. In the case of 17,274 rear seat passengers, only 0.72% used seatbelts. A total of 1,656 children below the age of five (approximately), were observed to travel in the cars, of which only 17 were in a booster seat.

A comparison of seatbelt usage surveys conducted in Thiruvananthapuram city in 2005 and 2016 show a substantial increase in seatbelt usage among both car drivers and front seat passengers. Driver seatbelt usage increased from 27% in 2005 to 77% in 2016. Front seat passenger seatbelt usage increased from 2% in 2005 to 16% in 2016. However, only 15 in every 100 front seat passengers wore a seatbelt, further significant improvement is required.

Study recommendations

Regarding helmet usage, it is found imperative that strong enforcement along with education awareness programs with publicity need to be adopted to increase the helmet wearing rates among motorcycle users (both riders and pillions) in Thiruvananthapuram. Once the awareness campaigns are completed, a post evaluation behavioral study on the helmet usage needs to be conducted to assess the impact of the initiatives undertaken.

Regarding seat belt usage, a target of 30% front seat passenger seatbelt usage could be immediately set for Thiruvananthapuram city. Coordinated Police enforcement and behavior change campaigns and publicity highlighting front seat passenger seatbelt law and penalties could increase the rate of seat belt usage. This campaign should be monitored closely and evaluated to set further, more ambitious targets and provide a model for seatbelt programs throughout Kerala. Virtually no rear seat passenger (0.72%) wore a seatbelt. Until the law mandating seatbelt wearing for rear seat passengers is implemented and enforced in Kerala, awareness activity is unlikely to result in any increase in seatbelt usage among this group. Virtually no child passenger is safely restrained. Awareness activity and school education programs could be implemented to highlight the benefits of seatbelts and child restraints for children and the danger of children less than 12 years of age sitting in the front seat.

42. Road Safety Measures for Road Section from Ulloor to Kuzhivila on NH 66 Bypass in Thiruvananthapuram City

Introduction

Road section from Ulloor junction to Kuzhivila junction on NH 66 bypass in Thiruvananthapuram city is a recently improved section and is found to be deficient in so many traffic safety features. This has resulted in many road accidents in the recent days after the improvement of the road. NATPAC has undertaken a road safety inspection of the road to identify the road safety deficiencies and suggest appropriate remedial measures.

Tasks carried out

As part of the study, road safety inspection was carried out to understand the existing topographical features, physical features and existing traffic characteristics along the project road. Based on the same, suitable safety measures were recommended.

Road safety issues and remedial measures

For the purpose of the study, the entire road stretch was divided into the following three sections namely:

No.	Road section	Length Km	Width M	ROW M
1	Ulloor Junction to Prasanth Nagar Junction	1.1	5-10	15
2	Prasanth Nagar Junction to Pulayanarkotta Junction	0.8	12-13	10-16
3	Pulayanarkotta Junction to Kuzhivila Junction	3.0	12-14	14-18

Improper intersection design, lack of adequate traffic signs and markings, absence of pedestrian facilities etc. are the main problems that are to be rectified in the study stretch. These problems enhance the road safety issues and therefore proper measures must be adopted to safeguard the road users and to allow smooth movement of traffic. The study road exhibits varying terrain from plain to rolling with sharp curves at many places. So while driving at night, it is recommended to provide road studs and street lights for better visibility at night.

Spot speed of the vehicles moving in the stretch was studied and it was observed that over-speeding of the vehicles was the reason for the accidents happening in the project stretch. As a short term measure, provision of rumble strips to regulate the speed of the vehicle moving at high speed and provision of speed limit sign to warn the road users to move with the safe speed in the area where schools and institutions are located in the project road were recommended.

Effective parking management and provision of parking space for vehicles, especially, two wheelers and cars, have to be provided. The entire road stretch is deficient of traffic signs. Road markings such as centre line, edge markings have to be provided.

Bus stop has to be relocated with well-designed bus bays provided with bus shelters. Effective parking management has to be done near the intersection. Road markings and traffic sign boards have to be provided in all the arms of the intersections. There must be provision of higher turning radius at junctions. The junctions are to be redesigned as per IRC specifications. Speed calming measures have to be provided.

The three major intersections such as Pulayanarkotta, Air Command junction and Althara road junction are to be improved to a great extent for better regulation of traffic in the project stretch to reduce road accidents in the section. Improvement proposal for the major junction are presented in **Figures 30, 31 and 32.**

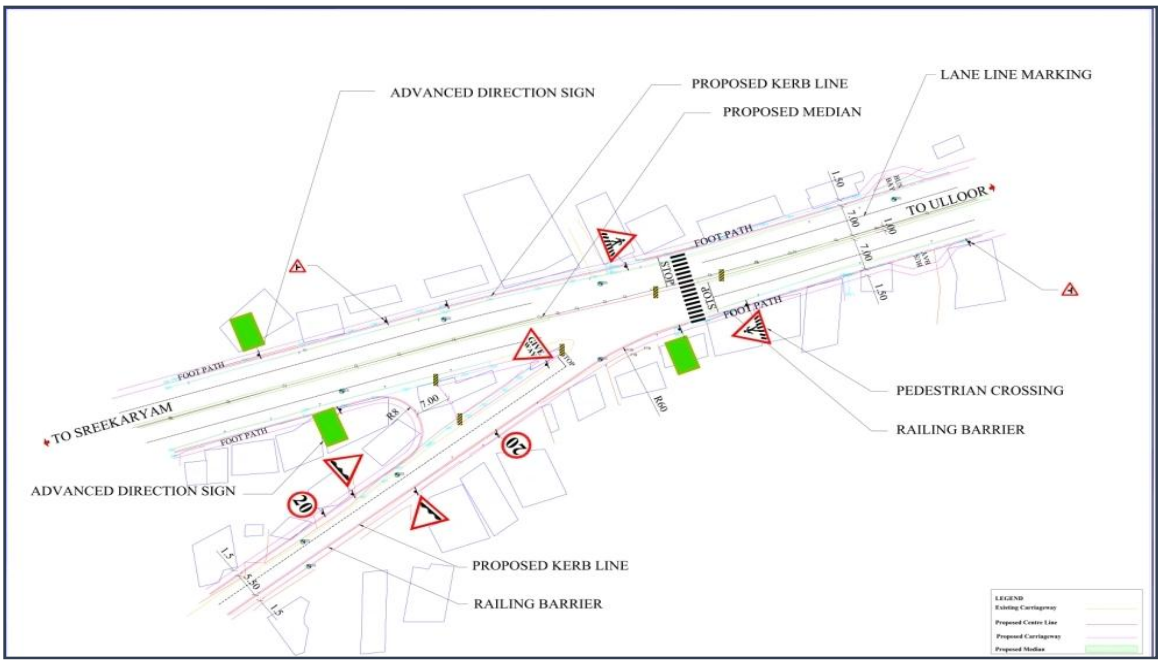


Figure 30: Improvement proposal for Pulayanarkotta intersection

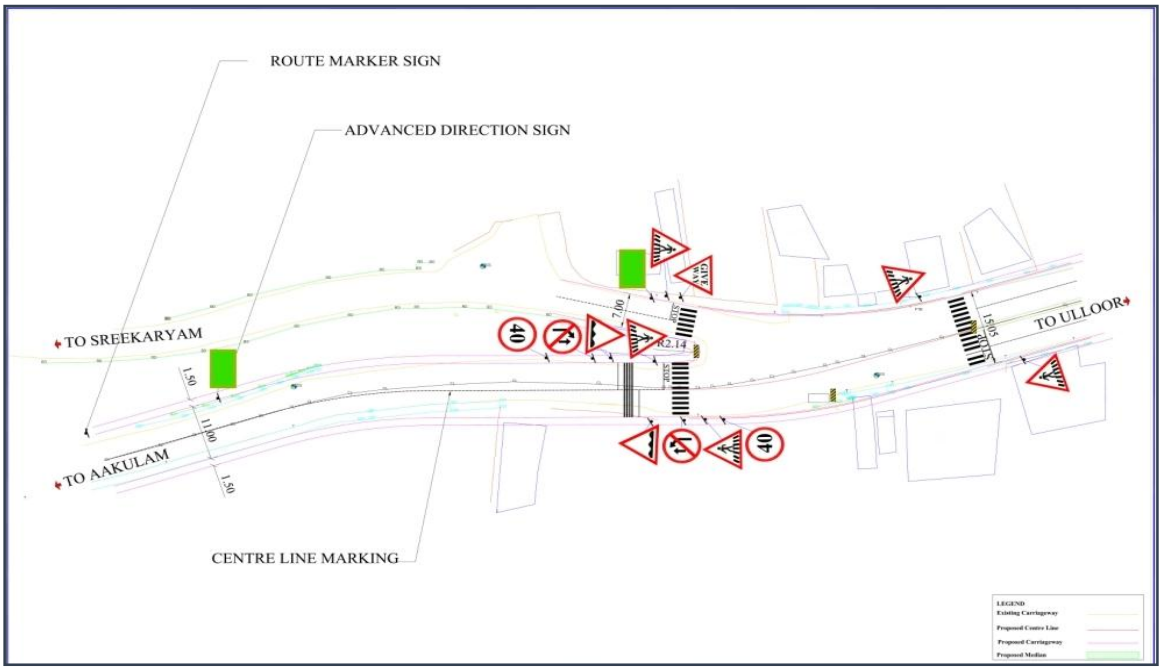


Figure 31: Improvement proposal for Air command intersection

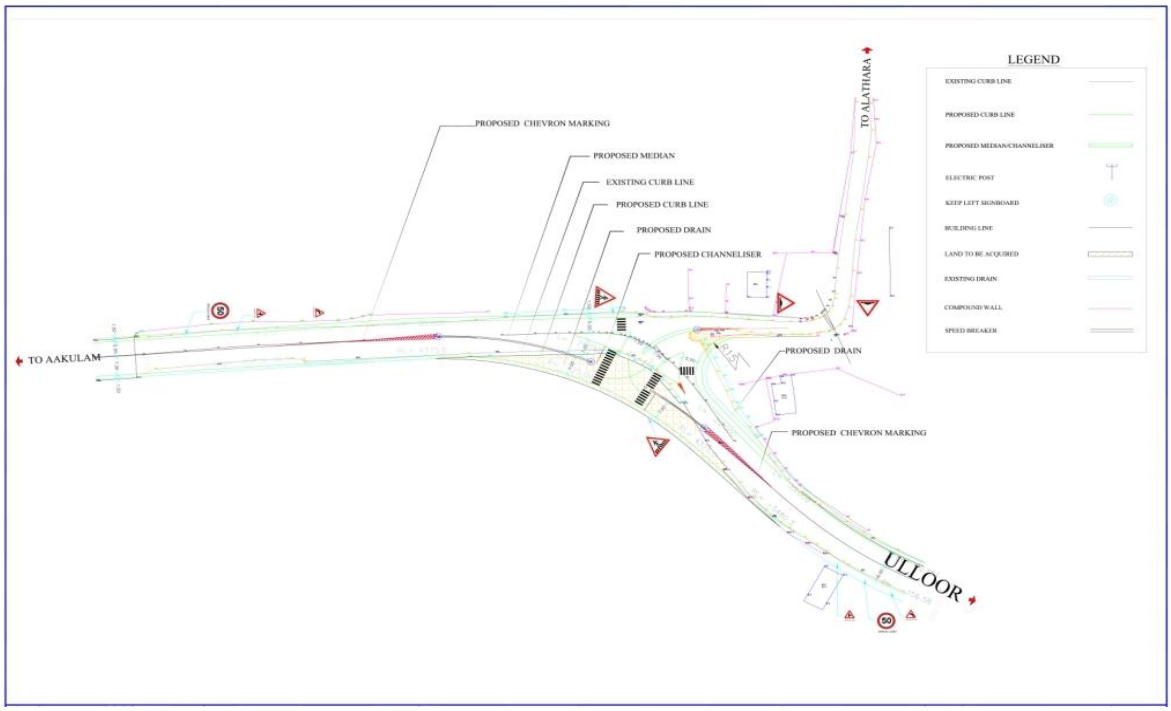


Figure 32: Improvement proposal for Althara intersection

Cost estimate

Rough cost estimates for implementation of various identified road safety improvement proposals has been worked out. Total cost estimate is about **Rs. 87 Lakhs**. The cost of acquiring the land was not considered in this cost estimate.

43. Assessment of Risk Potential of State Highways in Kerala – A Case Study of Ettumanoor – Ernakulam Stretch of SH – 15 in Kerala State

Introduction

Even after improving the road infrastructure with huge investments, the accidents and related fatalities and financial losses are increasing year by year. It is hence highly desirable to critically examine the existing road networks to determine the level of safety assured for their users and ultimately to generate a safe road investment plan to logically perform necessary amendments to enhance the overall safety of road users. In this context, NATPAC as part of the plan program during the year 2016-17 has embarked on assessing risk potential of a case study project namely SH 15-, Thrippunithura to Ettumanoor Stretch of State Highway in Kerala State and to propose road safety investment plans.

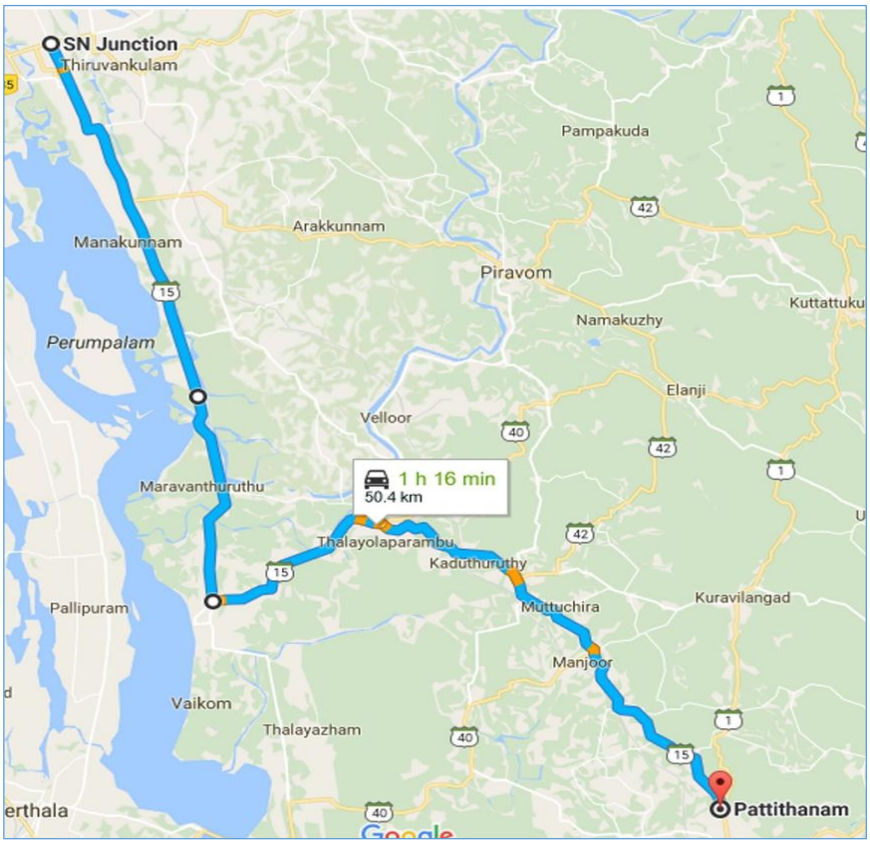


Figure 33: Study Stretch

Plate 13 (a)

Plate 13 (b)

Plate 13 (c)

Existing Safety Issues

Road Safety Issues and Remedial measures

iRAP methodology was followed and the road infrastructure is evaluated for its safety compliance towards various road users. Black spots and causes of accidents in the study stretch have been identified (**Table 21**) and remedial measures were suggested.

Table 21: Black spots identified along the Study Stretch

Sl No.	Black Spot	Coordinates	Most reported cause of accidents	Remedial measures
1	Puthenkavu jn. (II)	9.769710, 76.394965	Head on, hit from side, hit pedestrian	Junction improvement
2	Kaduthuruthy (I)	9.774624, 76.472683	Hit pedestrian, head on collision	Speed calming, delineation, pedestrian channelizing
3	Kattilkunnu jn.(II)	9.837377, 76.389665	Head on, hit from side, hit pedestrian	Junction improvement
4	Chempu post office jn. (III)	9.814779, 76.335975	Head on, hit from side, hit pedestrian	Junction improvement
5	Vallakom Jn. (III)	9.762215, 76.414879	Head on, hit from side, hit pedestrian	Visibility improvement, pedestrian channelizing

It is found that most of the road stretch is highly dangerous and unsafe for the four selected user category. In the case of pedestrian safety parameters, out of the 51km analyzed, pedestrian movement is in high risk in about 96% of the road length which caters considerable pedestrian volume where no facilities are being provided for the safe movement of the pedestrians. Likewise a prioritized list of up gradation works is generated for enhancement of the existing safety issues.

Based on the current road condition, countermeasures for improving the safety performance were suggested like provision of foot path, sight obstruction removal, improvement of curve delineation, pedestrian fencing at various locations, street lighting improvement, provision of shoulder rumble strips, provision of hard shoulders, signalized crossing at six major junctions, installation of road barriers, parking improvements, protected turn provision at existing signalized junction at Kuruppanthara, delineation at intersections, clearing of roadside hazards, school zone warning and providing school zone crossing supervisor.

44. *Investigation of Major Accident Spots, Causative Analysis and Mitigative Measures in Kerala*

Introduction

As part of the plan program of the Centre, NATPAC is continuously monitoring the accident scenario in the State by regularly undertaking on-the-spot investigation of recent accidents in the State, analyzing the causative factors and suggesting accident counter measures. Accordingly, NATPAC investigated five recent road traffic crashes that occurred in the year 2016-17.

Plate 14: Superfast v/s private bus accident at Ayur

Plate 15: Innova v/s iron sheet loaded trailer accident at Palachiramadu

Accident causative factors

Major causative factors for vehicular accidents have been observed as users' ignorance of basic vehicular characteristics, road geometry and surface condition, rules and regulations, excessive speeding, tailgating, poor lane keeping, dangerous overtaking, negligent lane changing, failure to give way, fatigue, inattentive driving nature, constraints in road geometry, lack of periodic maintenance, shortcomings in enforcement, lack of safe road infrastructure, incorrect road maintenance practices, inadequate training and licensing etc. **Figure 34** summarizes the road accident causative factors.

Major recommendations/suggestions evolved through the study are related to infrastructure, road safety education, issues requiring policy initiatives and enforcement. It is anticipated that, by implementing the recommendations, the incidence and severity rate on the analyzed road segments can be reduced considerably.

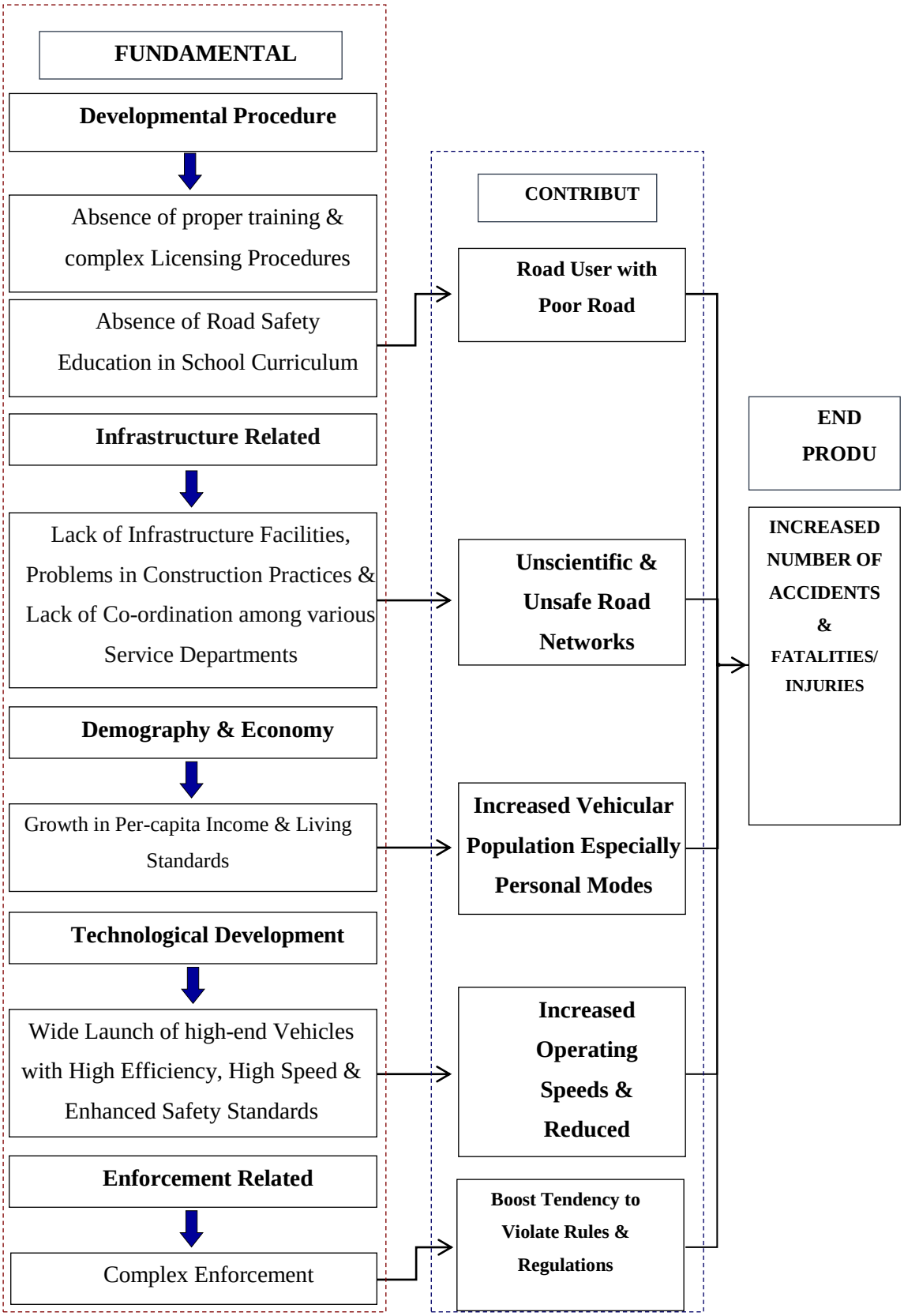


Figure 34: Accident Causative Factors

45. *Study on Accidents and Safety Aspects related to Inland Waterways in Kerala State*

Introduction

Inland water ways of Kerala are comparatively under-utilized and the density of traffic on waterways is very less compared to other modes. Due to this, number of accidents occurring in waterways is less compared to other modes. Though accidents are less compared to road sector, several high profile fatal boat accidents in passenger boats, barges and inland fishing boats have occurred in recent past. Safety of navigation assumes a set of conditions and requirements to be fulfilled by inland waterways, ports, navigation, boats and other vessels, the crew and supervision of implementation of navigational safety regulations. In this regard, NATPAC has embarked on a study to assess the accident and safety aspects related to inland waterways in Kerala. This study is a continuing one for three years, starting from the year 2016-17.

Main objectives of the study are to examine the existing rules and regulations related to inland waterways in safety aspect and examining their adequacy so that the need to make a policy for improving safety regulations are to be assessed from this. The causes of recent accidents in waterways are to be studied and the waterways in Kerala are to be examined in terms of safety and risks involved and improvement measures to be suggested. The scope of the work is limited to the accidents and other safety related aspects of the vessels operating in the inland waterways of Kerala.

Methodology adopted for the study

Methodology adopted for the study consisted of literature review, analysis of accident data, review of rules related to waterway, conducting stakeholder meeting, questionnaire survey for passengers and crew, waterway safety audit, preparation of disaster management plan for accidents in waterways, study of effectiveness of training programs, conducting safety awareness programs and preparing materials for creating awareness, preparation of hand books and best practice manuals for users of waterway and suggesting improvements to waterways for safe navigation.

Preliminary study findings

The review of rules related to inland waterways, analysis of accident data and questionnaire survey data analysis are in progress. Some of the observations are listed below:

- The duration for training program for boat crew for certification is four days, which is not sufficient for effective training;
- Safety measures in boats are to be improved;
- Jetties are to be made more safe;
- Awareness programs are to be conducted for passengers also.

Status of study

Accident data were collected from Alappuzha Port office and Kollam. Details of training programs conducted by Kerala Maritime institute were collected and discussions were made with various departments. Details of boats operated by SWTD are collected and conducted detailed safety audit survey of canals in Alappuzha. Detailed literature review were made for updation of laws and regulations and to get information about safety related training programs conducted in various parts of world and for preparation of guidelines.

46. Database Creation and Management for Inland Waterways in Kerala using Geographical Information System

Introduction

NATPAC had conducted many studies related to the inland waterways throughout Kerala and collected data regarding the existing waterway infrastructure. But all these data are not yet compiled into a common database to access them easily. It is proposed to compile all data related to water transport and tourism in Kerala and create a GIS data base to store and retrieve data for future reference as part of Plan program of the centre for the year 2016-17. This will make valuable information accessible quickly.

Major components of the study

- To compile the available data related to waterways in Kerala and related to various projects in NATPAC;
- To compile maps and other related data available in internet;
- To conduct field verification, wherever necessary;
- To create and manage a water way information system using GIS;
- Facilitate effective use of data.

A database in GIS platform is created for the data management and updation. Web GIS platform may be developed for this purpose with Bhuvan layers and toposheet as base layers.

Collaboration with Bhuvan team (NRSA) was also proposed by signing a MoU. It is proposed to develop a Windows based Web GIS system with all other components as open source.

Web GIS server components

The following are the components of Web GIS server;

- **Database Server:** The database server may have a file based system or Relational Database Management System (RDBMS) based or a combination of files and RDBMS.
- **GIS or Map Server**: Map server or GIS server is a software package or program, which is responsible for rendering the GIS data into web browser.
- **Application Server:** An application server is software which provides customized software applications.
- **Web Server:** A web server is a computer program which uses the client/server model and the World Wide Web's Hypertext Transfer Protocol (HTTP), serves the files that form web pages to web users.

EXTENSION SERVICES

1. *Road Safety Education through Schools in Kerala – Phase III*

NATPAC in association with Kerala Road Safety Authority (KRSA) conceptualized a Road Safety Training Programme "Road Safety Education through Schools in Kerala" which will help effectively in reducing the accident rate among children and also in saving the life of other road users. Through this training programme, school teachers of the State are trained on different facets of road safety.

The Phase III launching of the training programme was done by Sri. S.Aanantha Krishnan IPS, Additional Director General of Police and Transport Commissioner on 5th October 2016 at District Panchayath Auditorium, Thiruvananthapuram. The inaugural session was attended by Sri. R.Rajendran, Deputy Director (i/c), Department of Education.

Plate 21
Sri. S.Aanantha Krishnan IPS, Additional Director General of Police and Transport Commissioner inaugurating the Teachers Training Programme at Thiruvananthapuram

Plate 22
Presidential address by Dr. B.G.Sreedevi, Director, NATPAC

The following districts were covered under this project during the year 2016-17.

District	Date	No. of teachers participated
Kollam District	17th – 18th February 2017	102
Kottayam District	3rd – 4th March 2017	68

2. *Training Course for Drivers of Vehicles Carrying Dangerous and Hazardous Goods*

Government of Kerala accorded sanction to NATPAC for conducting 'Training Course for Drivers of Vehicles Carrying Dangerous and Hazardous Goods' vide G.O. (Rt) No.138/2015/Tran., dated 17th March 2015.

The State level inauguration of the programme 'Training on Safe Transportation of Hazardous Goods to Drivers' was done by Shri. Thiruvanchoor Radhakrishnan, Hon'ble Minister for Transport and Forest, Govt. of Kerala on 16th April 2015 at Sasthra Bhavan, Pattom, Thiruvananthapuram.

A total of 21 programmes were completed this year at the NATPAC office, *K Karunakaran Transpark*, Aakkulam, Thiruvananthapuram as per the following schedule.

Date	Number of drivers Participated
03/04/2016	50
13/04/2016	50
18/04/2016 – 20/04/2016	28
18/05/2016	31
29/05/2016	10
13/06/2016 – 15/06/2016	16
10/07/2016	14
14/08/2016	14
25/08/2016 –27/08/2016	41
27/08/2016	3
18/09/2016	21
14/10/2016	13
27/10/2016 –29/10/2016	28
29/10/2016	8
27/12/2016 –29/12/2016	38
29/12/2016	29
31/01/2017	20
03/01/2017	15
15/01/2017	16
17/03/2017	10
30/03/2017	37

Plate 23
Participants of 11th batch with Dr. B G Sreedevi, Director, NATPAC

3. Training to Junior Sub Inspectors of Police on 'Identification of Dangerous and Hazardous Goods and Dealing with Emergencies'

NATPAC in association with Kerala Police organised an one day training programme on 'Identification of dangerous and hazardous goods and dealing with emergencies' to Junior Sub Inspectors. The programme was formally inaugurated by Shri. Manoj Abraham IPS, IG of Police on 1st July 2015 at Sasthra Bhavan, Pattom.

NATPAC also conducted one programme at Palakkad, Training Hall, District Police Office on 29th June 2016.

4. Safe Community Programme for Panchayaths

A road safety program titled 'Safe Community Programme for Panchayath' has been designed by NATPAC with the intention of enforcing the 'zero-accident' policy of Government of Kerala. This programme aims to encourage local communities like Panchayaths to initiate and proactively seek ways to reduce accident risks. Panchayaths also need to be equipped for undertaking road safety projects/ programmes on their own.

The following Panchayaths were covered during this period:

Sl. No.	Details of Place & Venue	Participants	Date
1.	Balaramapuram Panchayath, Thiruvananthapuram District, at Vyapara Bhavan, Balaramapuram.	84 ACT Force volunteers, Panchayath members and Police representatives	20/08/2016
2.	Bharanikkavu Grama Panchayath, Alappuzha District, at Community Hall, Bharanikkavu.	109 ACT Force volunteers	29/09/2016
3.	Kanjirappally Panchayath, Kottayam District, at Lourdes Parish Hall, Kanjirappally.	151 Act Force volunteers, Panchayath members, Students and Police representatives	25/10/2016
4.	Pudukkad Grama Panchayath (Thrissur District), at Kodakara Block Panchayath Hall, Bharanikkavu.	109 Act Force volunteers	08/11/2016
5.	Alathoor Grama Panchayath (Palakkad District), at Vyapara Bhavan, Alathoor.	90 Act Force volunteers	15/11/2016
6.	Vattamkulam Grama Panchayath (Malappuram District), at C K Regency Community Hall, Edappal.	106 Act Force volunteers	15/12/2016
7.	Pappinissery Grama Panchayath (Kannur District), at Pappinissery Grama Panchayath Hall.	105 Act Force volunteers	20/12/2016
8.	Panayam Grama Panchayath (Kollam District), at Grama Panchayath Hall, Panayam.	161 Act Force volunteers and Panchayath members	23/03/ 2017

Plate 24
Class on Road Safety at Bharanikkavu Grama Panchayath

Plate 25
First Aid Training at Bharanikkavu Grama Panchayath

5. Road Safety Training Programme for Driving School Instructors

NATPAC organised training programme for driving school instructors by considering the fact that driving instructors play a pivotal role in tutoring students. The following six programmes were completed the year 2016-17.

Sl. No.	Details of Venue and Participation	Participants	Date
i.	Amal Jyothe College of Engineering, Koovappally, Kottayam District.	143 driving school instructors including ladies	26.10.2016
ii.	Vyapara Bhavan, Alathoor, Palakkad District.	29 driving school instructors including ladies and 28 drivers	16.11.2016
iii.	C K Regency Auditorium, Edappal, Malappuram District.	112 driving school instructors including ladies	14.12.2016
iv.	Kannur Police Co-Operative Bank Auditorium.	106 driving school instructors.	21.12.2016
v.	YMCA Hall, Kollam District.	236 driving school instructors	08.03.2017
vi.	Karmasadanam Auditorium, Alappuzha.	231 driving school instructors	29.03.2017

Plate 26
Driving School Instructors Training Programme at C K Regency Auditorium, Edappal

6. Road Safety Youth Leadership Programme

NATPAC launched a State-wide programme to train Young Volunteers in Road Safety and related aspects. The following 14 programmes on Road Safety Youth Leadership were completed this year.

Sl. No.	Details of Venue and Participation	Participants	Date
1.	K Karunakaran Transpark, Akkulam (for the volunteers of Thiruvananthapuram based Helping Hands Organization (H_2O)).	69 volunteers	16.07.2016
2.	Govt. Model Higher Secondary School, Varkala (National Service Scheme Volunteers) in association with the Energy Conservation Society (ECS)	64 students	26.07.2016
3.	Govt. Higher Secondary School, Balaramapuram.	98 students	07.09.2016
4.	K.K.M Govt. Higher Secondary School, Ilippakkulam, Alappuzha.	259 students	28.09.2016
5.	Achamma Memorial Higher Secondary School, Kalaketty.	120 students	28.10.2016
6.	Centre for Development in Advanced Computing, Thiruvananthapuram (CDAC)	Selected employees & students	03.11.2016
7.	Thiagarajar Polytechnic College, Alagappa Nagar, Amballoor for National Service Scheme Students.	88 students	09.11.2016
8.	NSS College, Nenmara for National Service Scheme Students.	127 students	18.11.2016

9.	Sree Narayana College, Alathoor for National Service Scheme Students.	74 students	18.11.2016
10.	Talent Institute of Management (TIMS), Edappal.	85 students	16.12.2016
11.	Pappinissery Panchayath Community Hall.	101	22.12.2016
12.	Gov.Vocational Higher Secondary School, Pirappencode for National Service Scheme volunteers.	50 volunteers	23.12.2016
13.	Mar Theophilus Training College.	35 students	27.01.2017
14.	Govt. Higher Secondary School, Cherunniyoor, Varkala.	137 students	16.02.2017

Plate 27
Shri G. Sivavikram IPS,
Deputy Commissioner of Police, Thiruvananthapuram, inaugurating the one day training programme on Road Safety and Youth Leadership at K Karunakaran Transpark, Akkulam

Plate 28
First Aid Training at K Karunakaran Transpark, Akkulam

Plate 29
Dr. B.G. Sreedevi, Director, NATPAC inaugurating RSYLP at Govt. HSS, Balaramapuram

7. Safe Road to School

NATPAC in association with Kerala Road Safety Authority organised one day programme on 'Safe Road to School' (SRS) at the following 16 schools.

Plate 30
Class on 'Road Safety' at K Karunakaran Smaraka Town Hall, Thrissur

Sl. No.	Details of Place, Venue and Participation	participants	Date
1.	Govt. UPS, Koothattukulam, Ernakulam in connection with the inauguration of the School Road Safety Cell.	100 students	02.07.2016
2.	K Karunakaran Smaraka Town Hall, Thrissur for Junior Red Cross Volunteers & Councillors.	1000 student volunteers and 150 student councillors	21.07.2016 – 22.07.2016
3.	Govt.Model Higher Secondary School, Varkala, jointly organised by NATPAC and Energy Conservation Society for Junior Road Safety Officers.	100 students	26.07.2016
4.	Govt. HSS, Prakkulam, Kollam, jointly organized by NATPAC and Energy Conservation Society.	100 students	23.08.2016
5.	Govt. HSS, Anchalumoodu, Kollam, jointly organized by NATPAC and Energy Conservation Society.	100 students	23.08.2016
6.	Govt. Higher Secondary School, Balaramapuram.	79 students	25.08.2016
7.	K.K.M Govt. Higher Secondary School for students of 7^{th} – 10^{th} Standards, Ilippakkulam, Alappuzha.	100 students	28.09.2016
8.	MYCA English Medium High School, Kanjirappally.	96 students	27.10.2016
9.	Govt. Higher Secondary School, Pattikkad, Thrissur.	95 students	07.11.2016
10.	St.Antony's High School, Pudukkad, Thrissur.	102 students	10.11.2016
11.	Vyapara Bhavan, Alathoor for school students in Alathoor.	108 students	17.11.2016
12.	Govt. Higher Secondary School, Edappal, Malappuram.	119 students	13.12.2016

13.	Govt. Higher Secondary School, Marayamuttam.	139 students	21.01.2017
14.	Govt. Higher Secondary School, Vettoor, Varkala.	500 students	03.02.2017
15.	Govt. Higher Secondary School, Cherunniyoor, Varkala.	137 students & teachers	16.02.2017
16.	Govt. LPS, Karikkodu, Kollam.	222 students & teachers	10.03.2017

Plate 31
Class on 'Road Safety' at K.K.M Govt. Higher Secondary School

Plate 32
Distribution of road crossing aids to wardens at Govt. HSS, Pattikkad by Sri. E.Babu, Sub Inspector of Police, Peechi

8. Training Programmes Conducted

a) In-house Training

Sl. No.	Details of Training	Date
i.	Discussion and demo presentation of Matlab Software to Scientists and Technical Officers by M/s CoreEL Technologies, Bangalore	31st August 2016
ii.	Demonstration of Matlab Software to Scientists and Technical Officers by M/s Math Works Image Processing and Computer Vision Technologies	27th October 2016

b) Road Safety Training for Various Target Groups

Sl. No.	Details of Training	Date
i.	Training on Road Safety and First-Aid for 200 Scout and Guide student volunteers in Neyyattinkara Educational Sub Division at Municipal Town Hall, Neyyattinkara	5th April 2016
ii.	Road Safety training programme for 50 school students in the Summer Camp organized by Institute of Engineers (India)	26thApril 2016

iii.	Traffic Management Training for traffic civil police officers, Sub Inspectors and Home Guards posted for traffic duties at Police Training College, Thiruvananthapuram	27th April 2016
iv.	Road Safety training programme for students as part of summer camp organized by State Central Library, Thiruvananthapuram. Around 300 students from different schools in Thiruvananthapuram district participated	28th April 2016
v.	Road Safety awareness programme for students as part of summer camp organized by Sree Varaham Vanitha Samithy, Thiruvananthapuram. About 50 students, teachers and parents participated	29th April 2016
vi.	Road Safety training programme for NCC cadets at St.Thomas College, Kozencherry, Pathanamthitta	29th April 2016
vii.	Training on Driving and Road Safety for Excise Drivers at State Excise Academy and Research Centre, Thrissur. 20 drivers participated	23rd August 2016
viii.	Training on Road Safety to Police drivers at Police Training College, Thiruvananthapuram. 30 drivers participated	31st August 2016
ix.	Road Safety Awareness Programme to general Public at St.Joseph's Church Auditorium, Kidarakkuzhi. 76 people participated.	11th September 2016
x.	Training to the volunteers of 'SOFT' (Save Our Fellow Traveller) on 'Trauma Care and Confidence Building in volunteers while attending Accident Victims' at Government Aollege Auditorium, Attingal	15th October 2016
xi.	Training on Road Safety to drivers of KSRTC, private stage carriers and autorickshaws at Office of the Deputy Superintendent of Police, Kanjirappally. 40 drivers participated	
xii.	Road Safety Education Programme to NCC Cadets at St. Stephen's College, Maloor, Pathanapuram	24th December 2016
xiii.	Training on Road Safety at Anganwadi, Pangode Ward. 42 members participated	4th February 2017

9. Exhibitions

1. Road Safety Exhibition and audio-visual programmes in connection with India International Science Fair, IISF 2016 at NPL, New Delhi, 7th – 11th December 2016. Received "Best Stall" award for KSCSTE from Dr. Harsh Vardhan, Hon. Minister for Science & Technology.
2. Road Safety Exhibition and audio-visual programmes in connection with Subhayathra (Kerala Police), Thiruvananthapuram, 24th January 2017.
3. Road Safety Exhibition and audio-visual programmes in connection with 29th Kerala Science Congress at Mar Thoma College, Thiruvalla, 28th -30th January 2017.

4. Road Safety Exhibition and audio-visual programmes in connection with Yantra 2017 at Attingal, Thiruvananthapuram, 22nd February 2017.

10. Participation in Workshops, Seminars/Conferences and other Training Programmes

Name of Programme	Organised by	Date (s)	Venue	Participants
Seminars/Conferences				
'Service Tax'	CII and Gulathi Institute of Finance and Taxation	07.04.2016	Thiruvananthapuram	Shaju D Maya Devi
5th Annual India Commercial Vehicle Summit		07.04.2016-08.04.2016	Pune	Sanjai R J
Ease of Business	CII	15.04.2016	Thiruvananthapuram	George Koshy Arun Chandran Anish Kini T Ramakrishnan Sanjai R J
GST	CII and Gulathi Institute of Finance and Taxation	15.04.2016	Thiruvananthapuram	Muhammed Naserudeen C
National Conference on Geotechnical Engineering & Modeling	IGS Trivandrum Chapter and LBS institute of Technology for Women	17.06.2016-18.06.2016	LBS Institute of Technology for Women, Thiruvananthapuram	Salini U
KERALA STATE MEET - 2016, Promoting Space Technology Based Tools and Applications towards Governance and Development	ISRO and Kerala State Remote Sensing and Environment Centre (KSREC)	08.11.2016	Hotel Hycinth Thiruvananthapuram	M S Saran
6th Asian regional conference on Geosynthetics		08.11.2016 – 11.11.2016	New Delhi	Salini U
GeoVision Seminar 2016	ESRI India	09.12.2016	Hilton Garden Inn , Thiruvananthapuram	M S Saran
Conference on Intelligent Transport System - A Game Changer		18.01.2017	New Delhi	Anish Kini
Introduction to Climate Change	Directorate of Environment & Climate Change (DoECC)	20.01.2017-21.01.2017	Apollo Dimora, Thiruvananthapuram	Jegan Bharath Kumar
International seminar on "Water management: combating climate uncertainties"	Directorate of Environment & Climate Change, GOK	22.03.2017-23.03.2017	Thiruvananthapuram	Jegan Bharath Kumar

Workshops				
How to become a Goody Goody Boss	Trivandrum Management Association (TMA)	17.06.2016	Mascot Hotel, Thiruvananthapuram	D Robinson V S Sanjay Kumar
Application of Geosynthesis in Infrastructure Projects	Central Board of Irrigation & Power (CBIP) and International Geosynthesis Society (India)	28.06.2016	Mascot Hotel, Thiruvananthapuram	Salini P N Wilson K C Jegan Bharath Kumar Chandra Pratap Salini U
Workshop organised by KMRL and CODATU		27.07.2016-28.07.2016	KMRL, Cochin	Ebin Sam
SAPCC Review Workshop	Department of Environment and Climate Change	20.08.2016	SP Grand Days, Thiruvananathapuram	V S Sanjay Kumar Wilson K C
National Workshop on 'Transformation of Business Using Google Cloud'	Computer Society of India, Tvpm Chapter	27.08.2016	Technopark, Trivandrum	Sanjai R J Deepa Radhakrishnan
National Symposium on Geotechnical Aspects of Pavement Structures	Govt. Engineering College, Barton Hill, Thiruvananthapuram	23.01.2017 – 25.01.2017	Govt. Engineering College, Barton Hill, Thiruvananthapuram	Salini U
Workshop on Research Writing: Technical and Language Aspects	NIT Calicut	12.02.2017	NIT Calicut	Sabitha N M
National Workshop on Information Technology Risks & Application Controls	Computer Society of India, Tvpm Chapter	17.03.2017	Hilton Garden Inn, Thiruvananthapuram	Deepa Radhakrishnan
Creating Awareness On Space Applications - Bhuvan	ESRI India	29.03.2017	LPSC, ISRO, Thiruvananthapuram	M S Saran Ebin Sam
Training Programmes				
17th IIRS Outreach Programme on 'Geoweb services and Geoportal applications'	Indian Institute of Remote Sensing (IIRS)	28.06.2016 – 15.07.2016	Dehradun	P Kalaiarasan M S Saran Ebin Sam
Recent Trends in Transportation Engineering	Dept. of Civil Engineering, NIT, Tiruchirappilli	11.07.2016 - 16.07.2016	NIT, Tiruchirappilly	Shaheem S
GIAN Course on "Non Destructive Testing of Pavements from Cradle to Grave"	IIT Madras, Chennai	05.12.2016 – 10.12.2016	IIT, Madras	V S Sanjay Kumar A Jegan Bharath Kumar
GIAN course on "Building Resilient and Sustainable Roadway Infrastructure"	IIT Madras, Chennai	12.12.2016-23.12.2016	IIT, Madras	P N Salini R Chandra Prathap U Salini
Health monitoring of structures	TKM college of Engineering, Kollam	20.02.2017-25.02.2017		Wilson K C

11. Guidance to Students' Internships/Project Work and Thesis

Students from various National Institutes and reputed Professional Colleges have undertaken their Internships /Project Works/Thesis under the guidance of NATPAC Scientists. The list of guidance provided by the Scientists is given below:

Name of the Institution	Course	Guide	No.of Students	Topic
National Institute of Technology, Karnataka, Surathkal	M.Tech (Transportn. Engineering)	Dr.B.G.Sreedevi	1	Study on the effect of Geometric Parameters on Road Safety – A Case Study of newly upgraded Highways in Kerala
National Institute of Technology, Kurukshethra	M.Tech (Transportn. Engineering)	Dr.B.G.Sreedevi	1	Utilization of Jarofix and other waste material for road construction
Cochin University of Science and Technology	M.Tech (Transportn. Engineering)	Dr.B.G.Sreedevi	1	Study on the influence of subgrade soil on the strength of inservice flexible pavements
Dayanand Sagar College of Engineering, Bangalore	M.Tech (Transportn. Engineering)	Shaheem S	4	• Study on the upgradation of bus routes in Thiruvananthapuram • Traffic analysis report for NH 47 in Tamil Nadu
National Institute of Technology, Karnataka	M.Tech (Transportn. Engineering)	Shaheem S T Ramakrishnan	5	Traffic and Transportation studies for Karamana City
National Institute of Technology, Trichy	M.Tech (Transportn. Engineering)	Shaheem S Arun Chandran	5	Traffic and Transportation studies for Piravam and Mananthavady Towns
National Institute of Technology, Kozhikode	M Plan (Urban)	Shaheem S	2	Design and Implementation of Traffic Management and Road Safety Measures to Gurgaon City
Amal Jyothi College of Eng. & Technology	B.Tech (Civil)	Shaheem S T Ramakrishnan	3	Traffic and Transportation study for Kattappana Town
Rajiv Gandhi Institute of Technology (RIT), Kottayam	M.Tech (Transportn. Engineering)	V S Sanjay Kumar	1	Accessibility based residential location modelling
Rajiv Gandhi Institute of Technology (RIT), Kottayam	M.Tech (Transportn. Engineering)	V S Sanjay Kumar	1	Modeling the impact of proposed Vizhinjam Transshipment terminal on Road Transportation
Mar Baselios College of Engineering	B.Tech (Civil)	Salini P N	6	Sustainable Transit System for Last Mile Connectivity in an activity centre – Technopark a Case Study
Mar Athanasius College of Engineering, Kothamangalam	B.Tech (Civil)	Salini P N	6	Mode choice for Last Mile Connectivity in Infopark
Rajiv Gandhi Institute of Technology (RIT), Kottayam	M.Tech (Transportn. Engineering)	Salini P N	1	Study on modal shift of home based work trips towards Kochi Metro

Musaliar College of Engineering and Technology, Pathanamthitta	B Tech (Civil)	Salini P N	4	Transportation infrastructure development for Harippad Town
Valia Koonambaikulathamma College of Engineering and Technology, Thiruvananthapuram	B Tech (Civil)	Salini P N	4	Parking management plan for Medical College Campus in Thiruvananthapuram
Musaliar College of Eng. & Technology, Pathanamthita	B.Tech (Civil)	Salini P N	4	Transportation studies for Harippad Town
Sarabhai Institute of Science and Technology, Thiruvananthapuram	B Tech (Civil)	Sabitha N M	3	Runoff estimation and identification of flood risk area using GIS
Gurudeva Institute of Science and Technology Kottayam	B Tech (Civil)	Sabitha N M	5	Threats in Inland Waterway Transportation (Alappuzha - Kottayam Canal)
SCMS College of Engineering, Ernakulam	B Tech (Civil)	Wilson K C	1	Performance evaluation of State Highway 1
BMS College of Engineering Bangalore	M Tech ((Transportn. Engineering))	Wilson K C	1	Performance evaluation Highway developed under KSTP
Sree Narayana Guru Institute of Science and Technology	B Tech (Civil)	Wilson K C	5	Re-Signalling of Kodungallur bypass
BMS College of Engineering, Bengaluru	M Tech ((Transportn. Engineering))	Wilson K C	1	Pavement Performance Modelling Using Artificial Neural Networks
LBS college of Engineering, Kasaragode	B Tech (Civil)	Wilson K C	6	Ongoing Activities at NATPAC
Musaliar College of Engineering, Pathanamthitta	B.Tech (Civil)	Arun Chandran	4	Pedestrian friendly transportation for Pathanamthitta
ACE College of Engineering	B.Tech (Civil)	Arun Chandran	4	Traffic and Transportation study for Piravam
Cochin University of Science and Technology	M.Tech (Transportn. Engineering)	Ebin Sam	1	Black spot identification in Ernakulam district
Rajiv Gandhi Institute of Technology (RIT), Kottayam	M.Tech (Transportn. Engineering)	Ebin Sam	1	Driver behaviour at pedestrian crossings
Rajiv Gandhi Institute of Technology (RIT), Kottayam	M.Tech (Transportn. Engineering)	Ebin Sam	1	Development of GIS based traffic-road database
Mangalam College of Engineering, Ettumanoor, Kottayam	B Tech (Civil)	Jegan Bharath Kumar.A	4	Assessment of Pedestrian facilities in major corridors in Thiruvananthapuram City

Gurudeva Institute of Science & Technology, Payyappady, Kottayam	B Tech (Civil)	Jegan Bharath Kumar.A	5	Improvement and analysis of Ulloor-Kuzhivila Road
Sree Buddha College of Engineering, Elavumthitta, Pathanamthitta	B Tech (Civil)	Jegan Bharath Kumar.A	4	Use of waste plastic in subgrade layer of Flexible Pavement
Sarabhai Institute of Science and Technology,Vellanad	B Tech (Civil)	Jegan Bharath Kumar.A	5	Performance of waste plastic in soil subgrade
Rajiv Gandhi Institute of Technology (RIT), Kottayam	M.Tech (Transportn. Engineering)	Chandra Prathap R	1	Cost Variation Analysis of Flexible Pavements subjected to Overloaded Trucks
National Institute of Technology, Kurukshethra	M.Tech (GE)	Salini U	1	Numerical modeling of highway embankment constructed with soil-jarofix mixture
Rajiv Gandhi Institute of Technology (RIT), Kottayam	M.Tech (GE)	Salini U	1	Laboratory investigation on zychotherm modified bituminous mixes
Rajiv Gandhi Institute of Technology (RIT), Kottayam	M.Tech (GE)	Salini U	1	Characterization of RAP for use of flexible pavement construction
Sarabhai Institute of Science and Technology, Thiruvananthapuram	M.Tech (Geotechnical Engineering)	Salini U	1	Utilisation of red mud using lime as an embankment material
Sarabhai Institute of Science and Technology, Thiruvananthapuram	M.Tech (Geotechnical Engineering)	Salini U	1	Feasibility study of utilizing waste sand and POFA in stabilizing kuttanaad clay
Sarabhai Institute of Science and Technology, Thiruvananthapuram	M.Tech (Geotechnical Engineering)	Salini U	1	Geotechnical behaviour of red soil on addition of sawdust with lime
College of Engineering, Thiruvananthapuram	M.Tech. (GE) Mini Project	Salini U	1	Suitability of industrial sludge as a pavement material
Cochin Institute of Science and Technology, Muvattupuzha	B.Tech (Civil)	Salini U	4	Laboratory Investigation of porous asphalt mixes containing NRMB and polypropylene fibres
Mar Ephraem college Engineering and Technology, Elauvilai	B.Tech (Civil)	Salini U	2	Performance evaluation of stone matrix asphalt and bituminous concrete
Layola College Engineering , Nagercoil	B.Tech (Civil)	Salini U	1	Utilization of red mud as a construction material
Sarabhai Institute of Science and Technology, Thiruvananthapuram	M.Tech (Geotechnical Engineering)	Salini U	1	Utilisation of red mud using lime as an embankment material
Rajiv Gandhi Institute of Technology (RIT), Kottayam	M.Tech (Transportn. Engineering)	B.Anish Kini	1	Evaluating the impact of flyover construction over signalised intersections: A case study
Rajiv Gandhi Institute of Technology (RIT), Kottayam	M.Tech (Transportn. Engineering)	B.Anish Kini	1	Impact of introducing congestion charging using Dynamic assignment in Vissim: A case study of Thiruvananthapuram city

Sreebudhha College of Engineering	B.Tech (Civil)	Sanjai R J	6	Small Industrial Training Prgramme Report
College of Engineering, Trivandrum	MBA	Sanjai R J	6	Ongoing activities of NATPAC

12. Presentation of Papers in Seminars/Workshops

Sl. No.	Author(s)	Paper details	Date
i.	Sreerag, Shaheem S	"*Mode Choice Behaviour of Work Trips in Thiruvananthapuram"*. International Conference on Recent Trends in Civil Engineering, Architecture and Environmental Engineering for Global Sustainability(CEAEGS -2016) organised by Krishi Sanskriti Publications at Jawaharlal Nehru University, New Delhi.	23/04/2016
ii.	Shaheem S, T Ramakrishnan, B G Sreedevi	**"***Sustainable Urban Transit System for Thiruvananthapuram City in Kerala"*, 12th Kerala Environment Science Congress jointly organized by Centre for Environment and Development (CED) and Energy Management Centre (EMC) at EMC Trivandrum	28/11/2016 - 30/11/2016
iii.	Aarsha S Hari, Shaheem S, T Ramakrishnan	*"Study on Rationalization of Public Transport Services in Thiruvananthapuram City"*, 29th Kerala Science Congress, jointly organised by KSCSTE and KFRI at Mar Thoma College, Thiruvalla	28/01/2017 - 30/01/2017
iv.	Gopika Mohan, Shaheem S, T Ramakrishnan	*"Parking Management Plan for Proposed LRT Stations in Thiruvananthapuram City"*, 29th Kerala Science Congress, jointly organised by KSCSTE and KFRI at Mar Thoma College, Thiruvalla	28/01/2017 - 30/01/2017
v.	V S Sanjay Kumar, Suby Charles, Wilson K C	*"Analysis of level of Compliance of Seat Belt Usage in Selected Cities in Kerala"*, 29th Kerala Science Congress, jointly organised by KSCSTE and KFRI at Mar Thoma College, Thiruvalla	28/01/2017 - 30/01/2017
vi.	P Kalaiarasan	*"Vehicular Emission Ranking of Major Road Corridors in Thiruvananthapuram Urban Centre"*, 12th Kerala Environment Science Congress jointly organized by Centre for Environment and Development (CED) and Energy Management Centre (EMC) at EMC Trivandrum	28/11/2016 - 30/11/2016
vii.	P Kalaiarasan	*"Environmental Improvement of selected canals in Alappuzha region"*, 29th Kerala Science Congress, jointly organised by KSCSTE and KFRI at Mar Thoma College, Thiruvalla	28/01/2017 - 30/01/2017
viii.	Salini P N, Ardra S Krishna, Jomy Thomas	*"Study on Modal Shift of Home-based Work Trips towards Kochi Metro"*, 29th Kerala Science Congress, jointly organised by KSCSTE and KFRI at Mar Thoma College, Thiruvalla	28/01/2017 - 30/01/2017
ix.	Salini P N, AnishKini B	"*Collective Operational Efficiency of Signal Systems with Red Light Camera*", Poster presented at 29th Kerala Science Congress, jointly organised by KSCSTE and KFRI at Mar Thoma College, Thiruvalla	28/01/2017 - 30/01/2017

x.	Salini P N, T Ramakrishnan, B G Sreedevi	"*Feasibility of Long Haul Bus Terminal (LHBT) on Chala Bypass in Thiruvananthapuram City*", National Conference on Technological Advancements in Civil & Mechanical Engineering (NCTACME'17) at KMEA Engineering College, Aluva	17th – 18th March 2017
xi.	Sabitha N M B G Sreedevi	"*Renovation of Inland Waterways for Tourism and Passenger Transport- A case study of Kadambrayar River in Kochi*", Proceedings of 12th Kerala Environment Science Congress jointly organized by Centre for Environment and Development (CED) and Energy Management Centre (EMC) at EMC Trivandrum	28th -30th November 2016
xii.	Sabitha N M Santosh G Thampi, Sathish Kumar D	*"Estimation of flood hazard map for Killi Basin using GIS based Morphometric parameters"*, Poster presented in National Symposium on Recent Advances in Remote Sensing and GIS with Special Emphasis on Mountain Ecosystems organised by Indian Institute of Remote Sensing at Dehradun	7th – 9th December 2016
xiii.	Sabitha N M Santosh G -Thampi Sathish Kumar D	*"GIS based morphometric analysis for flash flood estimation in Killi Basin"*, Proceedings of the 21st International Conference on Hydraulics, Water Resources and Coastal Engineering (HYDRO 2016), organised by The Central Water and Power Research Station (CWPRS), Pune	8th - 10th December 2016
xiv.	Sabitha N M, B G Sreedevi	*"Management of Inland Waterways for Tourism and Passenger Transport in Kochi Region"*, Proceedings of 21st International Conference on Hydraulics, Water Resources and Coastal Engineering (HYDRO 2016) organised by The Central Water and Power Research Station (CWPRS), Pune	8th - 10th December 2016
xv.	Sabitha N M , B G Sreedevi, Salini U	"*Canal bank breaching vulnerability analysis in Alappuzha and Kuttanad regions*", Proceedings of 29th Kerala Science Congress, jointly organised by KSCSTE and KFRI at Mar Thoma College, Thiruvalla	28th -30th January 2017
xvi.	Wilson K C, Salini U, Salini P N, B.G.Sreedevi	*"Evaluation of Zycotherm Modified Bituminous Mix"*, Proceedings of 29th Kerala Science Congress, jointly organised by KSCSTE and KFRI at Mar Thoma College, Thiruvalla	28th -30th January 2017
xvii.	Wilson K C, P N Salini, V S Sanjay Kumar	*"Transportation Demand Management for an IT Park with Direct Access to National Highway"*, 12th Kerala Environment Science Congress jointly organized by Centre for Environment and Development (CED) and Energy Management Centre (EMC) at EMC, Trivandrum	29-30th November 2016
xviii.	A Jagan Bharath Kumar, T Ramakrishnan	*"Strategy for Improving Walkability: A Case Study of Thiruvananthapuram City"*, 29th Kerala Science Congress, jointly organised by KSCSTE and KFRI at Mar Thoma College, Thiruvalla	28th -30th January 2017
xix.	R Chandra Prathap, Wilson K C, V S Sanjay Kumar	*"Design Improvements for Accident Prone Curve at Vattappara in NH 17-A Case Study"*, 29th Kerala Science Congress, jointly organised by KSCSTE and KFRI at Mar Thoma College, Thiruvalla	28th -30th January 2017
xx.	Vishnu Krishnan Arora V K Salini U	**"***Utilizationof Biaxial Geogrid in Embankments Constructed with Jarofix"*, Proceedings of 6th Asian Regional Conference on Geosynthetics at New Delhi	8th – 11th November 2016

xxi.	Anoop T Vijayan, Remjish R S, Salini U, B G Sreedevi	*"Use of Coir Fibrein Stone Matrix Asphalt for Pavement Construction"*, Proceedings of 6th Asian Regional Conference on Geosynthetics at New Delhi	8th - 11th November 2016
xxii.	Aswathy M, Gayathri V G, Salini U	**"***Utility of Lime and Red Mud in Clay Soil Stabilization"*, Proceedings of Indian Geotechnical Conference (IGC 2016) at IIT Madras	15th – 17th December 2016
xxiii.	Laya N N, Salini U	**"***Lime Stabilization of Subgrade with Waste Sand as Partial Soil Replacement"*, Proceedings of Indian Geotechnical Conference (IGC 2016) at IIT Madras	15th -17th December 2016
xxiv.	Jobson Joseph**,** B Anish Kini	*"Impact of Implementing Congestion Charging using PTV Vissim"*,9thUrban Mobility India Conference 2016 at Gandhi Nagar	08-11 November 2016

Papers Published in Referred Journals

- **G R Amrutha Lekshmi, VishrutLandge, V S Sanjay Kumar**, *Activity Based Travel Demand Modelling of Thiruvananthapuram Urban Area.* Transportation Research Procedia 17, 2016, P.P.498 – 505.
- **Bivina G R, Vishrut Landge, V S Sanjay Kumar**, Socio-economic Valuation of Traffic Delay. Transportation Research Procedia 17, 2016, P.P. 513 – 520.
- **Subin B**, Modelling Safety Risk Perception due to Mobile Phone Distraction among Four Wheeler Drivers. IATSS Research, 2016.
- **Subin B**, Assessment and Modelling of In-vehicle Distracted Driving in Kerala. Journal of Recent Innovations in Technology, 2016.
- **Ardra S Krishna, Jomy Thomas, Salini P N** , Study on Modal Shift of Home-based Work Trips towards Kochi Metro. Indian Highways, Vol.45 (2), February 2017, P.P. 21-28.
- **Salini P N, T Ramakrishnan, B G Sreedevi,** Feasibility of Long Haul Bus Terminal (LHBT) on Chala Bypass in Thiruvananthapuram City. International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET), Vol.6 (Special Issue 4), March 2017.
- **Wilson K C, Salini P N, B G Sreedevi,** Limited Use Road Over Bridges for Light Vehicles in Lieu of Low Train Vehicle Unit Level Crossings. Indian Highways, Vol.45 (4), April 2017, P.P.35-47.
- **Vishnu Krishnan, V K Arora, Salini U**, "Evaluation of Jarofix-Soil Embankment using Numerical Modelling". International Journal of Earth Sciences and Engineering, Vol.09 (6), December 2016, P.P.2871-2877.

Articles

- **B G Sreedevi, T Ramakrishnan, Ebin Sam**, Managing Thiruvananthapuram's M.G.Road. Traffic Infratech Magazine. (August-September 2016; Volume-7, Issue-1)
- **V S Sanjay Kumar,** Walkability: Concept and Issues. Kerala Calling Magazine, January 2017
- **Ebin Sam**, 'Parking Management of M.G road in Kerala. Traffic Infratech Magazine.

13. *Invited Talks/Media Interactions*

Dr. B G Sreedevi

Media Interactions

Sl. No.	Topic	Media	Date
1.	*'Government of India's Road Safety'*	Discussion in 'Varthamanakalam', Doordarshan	01/04/2016
2.	*'Programme on Road Safety'*	'Malayali Durbar', Amrita Channel	02/04/2016
3.	*'Development Agenda'*	Discussion in Asianet News Channel	15/04/2016
4.	*'Varthamanakalam'*	Doordarshan	02/06/2016
5.	*'Two Wheeler Accidents'*	All India Radio, Thrissur	17/08/2016
6.	*'Programme on Road Safety'* in Varthatharangini	All India Radio, Thrissur	22/08/2016

Invited Talks

Sl. No.	Topic/Particulars	Venue/Event	Date
1.	*'Energy Efficiency and Productivity'*	District Level Seminar organized by Energy Conservation Society, Kochi	03/05/2016
2.	*'Climate Change and Technological Advancements'*	'Workshop on Climate Change and Technological Advancements' organized by Institute for Climate Change Studies (ICCS), Kottayam	04/05/2016
3.	*'Safe Road Infrastructure for Zero Mortality'*	National Seminar on Trauma Care organized by Indian Medical Association, Trivandrum	04/08/2016
4.	*'Road Safety'*	Citizen Initiative Trust, Trivandrum	07/08/2016
5.	Convocation Address	Vidya Academy of Science and Technology, Thrissur	12/08/2016
6.	*'Save our Fellow Traveler'*	Inauguration of the 'SOFT'- an initiative of Kerala Police at Ananthapuri Hospital, Thiruvananthapuram	03/09/2016
7.	*'Two Wheeler Safety'*	Seminar of Two Wheeler Safety organised by 'Safety Ride'	19/03/2019

P. Kalaiarasan

Invited Talk

Sl. No.	Topic	Venue/Event	Date
1.	*'Transportation Sector'*	'Workshop on Climate Change and Technological Advancements'organized by Institute for Climate Change Studies(ICCS), Kottayam	04/05/2016

Salini P. N.

Invited Talk

Sl. No.	Topic	Venue/Event	Date
1.	*'Demand Modelling, Bus Terminal Design and Pavement Design'*	Rajadhani Institute of Engineering and Technology, Attingal	18/07/2016
2.	*'Transportation Planning and Management'*	Viswajyothi College of Engineering and Technology, Vazhakulam	31/08/2016
3.	*'Highway Materials and Pavement Evaluation'*	Talk delivered at Ilahia College of Engineering and Technology on request of Civil Engineering Association	31/10/2016

U. Salini

Invited Talk

Sl. No.	Topic	Venue/Event	Date
1.	*'Testing Methods of Pavement Materials'*	Talk delivered at the National Symposium on Geotechnical Aspects of Pavement Structures at Govt. Engineering College, Barton Hill, Thiruvananthapuram	23/01/2017 – 25 /01/2017

14. *Nominations to Technical Committees/Advisory Bodies/Membership of Professional Institutions*

Dr. B. G. SREEDEVI

- Official Member, Board of Directors of Kerala State Road Transport Corporation (KSRTC), Government of Kerala (2012- continuing)
- Official Member, Board of Directors of Kerala Urban Road Transport Corporation

(KURTC), Government of Kerala (2014- continuing)

- Member of the committee for preparation of plan document for Inland Water Transport for 13th Five year plan , Kerala State Planning Board (Served as convener of the sub-committee for preparing the report), 2016
- Member of the committee for preparation of plan document for Housing for 13th five year plan , Kerala State Planning Board, 2016
- Chairman, Technical Committee for Study of the proposal for demolishing the ramp to Thiruvananthapuram International Airport, G.O (R.t) No.327/2016/Trans, dated 11.08.2016, Government of Kerala
- Member, Committee for Coastal Highway (G.O.(R.t) No.1343/2016/PWD dated 30.09.2016), Government of Kerala
- Member, Committee for Hill Highway (G.O.(R.t) No.1343/2016/PWD dated 30.09.2016), Government of Kerala
- Member Committee, Technical Scrutiny of DPR, PWD, (G.O.(R.t) No.1726/2016/PWD, dated 19.12.2016, Government of Kerala
- Member, TS Committee for PWD Projects related to KIIFB, Government of Kerala (2016-17)
- Member, Evaluation Committee of KRFB for the selection of Transaction Advisor for Alappuzha City road improvement project (NO : 75/P2/KRFB/2017 dtd.20-5-17)
- Expert member for the selection of G M, DGM for Kerala Road Fund Board (No. 3071/ EL/ KRFB/2016 dtd. 19-6-2017)
- Member, Technical Committee for scrutiny of DPR for Alappuzha City Road improvement project. (GO (Rt) NO:1090/2017/PWD dtd 26-7-2017)
- Member, Expert committee for review of TRDCL claims of City Road Improvement Project (GO (Rt) No: 1674/2017/PWD dtd. 10-11-2017)
- Member of consultative committee, Transportation Engineering Research Centre(TRC), College Of Engineering, Trivandrum (2012 onwards)

SHAHEEM S.

- Technical member of State level expert committee for Atal Mission for Rejuvenation and Urban Transformation (AMRUT) project

P. KALAIARASAN

- Nominated as Nodal Officer for Climate Change Cell, Directorate of Environment and Climate Change, Govt. of Kerala.

M. S. SARAN

- Nominated as Nodal Officer for Space Based Tols and Application Development, Kerala State Remote Sensing and Environment Centre, Govt. of Kerala.

P. N. SALINI

- IRC Membership (Roll No M– 32094)
- Membership in Institute of Urban Transport (India) - Membership No M–1493
- Treasurer IUT(I) – Kerala Chapter

WILSON K. C.

- Technical Member – Kerala Road Safety Authority

EBIN SAM

- Life Member, Indian Roads Congress (e-LM 100932)
- Kerala Economic Association - Life Membership

JEGAN BHARATH KUMAR A.

- Designated as Nodal Officer for Climate Change Cell by Directorate of Environment and Climate Change (DoECC), Government of Kerala.

ANISH KINI

- Selected as Secretary of Institute of Urban Transport (India) - Kerala Chapter in Annual General Body Meeting held on 31.05.2016.
- Member of Institute of Transportation Engineers, USA.

15. Achievements

SHAHEEM S

- Received Certificate of appreciation from KSCSTE for co-ordinating the activities of all R & D centers that enabled to receive "Best Stall" award in India International Science Festival (IISF-2016)

P. N. SALINI

- First Rank for Diploma in Transport Economics and Management by Institute of Rail Transport, New Delhi, 2017

ANISH KINI

- Gold Medal for Diploma in Transport Economics and Management by Institute of Rail Transport, New Delhi, June 2016

16. *Road Safety Education Materials*

Films

1. Savari, A Documentary Film on Road Safety – For Auto rickshaw Drivers
2. Gathy, A Short Film on Two Wheeler Safety
3. IRC Film (English and Malayalam) – For School Children
4. Right Step (English and Malayalam) – For School Children
5. VIC Roads, Australia – For School Children
6. A Picnic on Pedals – For School Children
7. Vazhikkannumai – On Pedestrian Safety
8. Sradhha – Transportation of GoodsVehicles
9. Take care
10. A Film on Seatbelt
11. A film on Rash Driving
12. A Film on Pedestrian Crossing

Booklets

1. Safe Road to School (English & Malayalam)
2. Preventing Accidents
3. Two Wheeler Driving Manual
4. Road Safety Manual for Goods Vehicle
5. All about Lane Driving and Road Safety
6. Safe Cycling
7. Autorickshaw Driving Manual (English & Malayalam)
8. Defensive Driving
9. Teacher's Manual (English & Malayalam)
10. Safe Community Programme for Panchayats (English & Malayalam)
11. Helping Road Accident Victims (English & Malayalam)
12. Rules of Road Regulations,1989
13. On Car and Safe Driving
14. Defensive Bus Driving and Road Safety Guide
15. Road Safety Slogan
16. Vehicle Upkeep and Safety
17. Alphabets of Road Language
18. Road Safety Quiz
19. Safe and Responsible Parking
20. Road Safety and Youth Leadership Programmes
21. Safety Rules for Railway Level Crossing and Around Tracks
22. Safe and Secure Travel by Train
23. Driver's Guide (Malayalam)
24. Formation and Activities of Road Safety Cell in Schools (Malayalam)
25. കാൽനട യാത്രക്കാർക്കുള്ള സുരക്ഷാ മാർഗരേഖ
26. സ്കൂൾ കുട്ടികൾക്കുള്ള റോഡ് സുരക്ഷാധിഷ്ഠിത ബോധവത്കരണം
27. പപ്പു ഉറങ്ങുകയല്ല

28. സുരക്ഷിതമായ സൈക്കിൾ സവാരി
29. സുരക്ഷിത പാർക്കിംഗ്
30. റോഡിലെ ഭാഷയുടെ അക്ഷരമാല
31. റോഡ്സുരക്ഷാ മുദ്രാവാക്യങ്ങൾ
32. റോഡ് ഗതാഗത നിയന്ത്രണ ചട്ടങ്ങൾ
33. ലെയിൻ അധിഷ്ഠിത ഡ്രൈവിംഗും റോഡ് സുരക്ഷയും
34. പ്രതിരോധാത്മക ഡ്രൈവിംഗ്
35. റോഡ് സുരക്ഷയും യുവജന നേതൃത്വ പരിപാടികളും
36. ഇരുചക്ര വാഹനമോടിക്കുന്നവർക്ക് ഒരു കൈപുസ്തകം
37. ചരക്ക് വാഹനങ്ങൾക്കുള്ള റോഡ് സുരക്ഷാ സഹായി
38. പ്രതിരോധാത്മക ബസ് ഡ്രൈവിംഗും റോഡ് സുരക്ഷയും
39. റോഡപകടങ്ങൾ തടയുന്നതിനുള്ള മാർഗങ്ങൾ
40. വാഹനങ്ങളുടെ പരിപാലനവും സുരക്ഷയും

Student Badges

1. Be Careful and Be Safe
2. Don't Be Safety Blinded Be Safety Minded
3. Follow Traffic Rules and Be Safe
4. You Can't Fix Your Brain at a Body Shop – Buckle Up!
5. Road Safety is a Mission, Not an Intermission
6. Before Crossing Stop! Think! Then Act
7. Kindness is Giving the Right of Way
8. Look Carefully and Drive Safely
9. Be smart, think, then Start
10. Leave sooner, drive slower, live longer
11. Drive as if every child on the street were your own
12. Be careful and be safe
13. At work at play let safety lead the way
14. Safety is a simple ABC- Always Be Careful
15. Safety on road, Safe tea at home
16. The safe way is the best way
17. While Driving Put off Mobile! Put on Seat Belt!
18. Better to Arrive Late Than Never
19. Courtesy and Common Sense Promote Road Safety
20. നിൽക്കൂ!ശ്രദ്ധിക്കൂ!റോഡ് മുറിച്ച് കടക്കൂ!
21. സൂക്ഷിച്ച് വാഹനമോടിക്കൂ, റോഡിലെ തിരക്കിൽ നിങ്ങളുടെ കുട്ടികളും ഉണ്ടായിരിക്കാം
22. വേഗതയിലല്ല സ്മാർട്ടാകേണ്ടത്, സുരക്ഷയിലാണ്
23. ശ്രദ്ധിച്ച് നോക്കൂ, സുരക്ഷിതമായി ഡ്രൈവ് ചെയ്യൂ
24. സുരക്ഷിതത്വം മഹത്വമാണ്
25. വീഥിയിലൂടെ വേഗത വേണ്ട
26. ശ്രദ്ധിക്കൂ സുരക്ഷിതരായിരിക്കൂ
27. അശ്രദ്ധ അപകടമാണ്

28. നേരത്തെ ഇറങ്ങൂ, നേരെ ഓടിക്കൂ, നേരായവിധം ജീവിക്കൂ
29. ശ്രദ്ധയുള്ളിടത്ത് സുരക്ഷ ഉണ്ട്
30. പാഞ്ഞു പോകരുത്, പ്രാണൻ എടുക്കരുത്
31. സുഗമമായ പാത നിങ്ങളുടെ മാത്രം സ്വന്തമല്ല

Calenders

1. Steps to Use Bus safely
2. Safe Road to school – Crossing the Road Safely
3. Safe Road to School – Kerb Drill
4. Safe Road to school – Lessons from Animals
5. Road Signs
6. Important Road Safety Tips for Children
7. കുട്ടികൾക്കു വേണ്ടിയുള്ള പ്രധാനപ്പെട്ട റോഡ് സുരക്ഷാ സൂചനകൾ

Leaflets

1. Who is Walking on the Wrong Side
2. Police Hand signals
3. Safe and Correct Ways of Parking
4. Protect your Child from Injury
5. Spot the Hidden Dangers
6. Two Wheeler Driving
7. Follow this Simple Kerb Drill
8. School Safety – A Checklist for Parents
9. Understanding Traffic Rules and Regulations (English & Malayalam)
10. Don't Be Rash and End in Crash (English & Malayalam)
11. Helmets (English & Malayalam)
12. Golden Rules for Defensive Driving (English & Malayalam)
13. Untied Duppatta/Saree – Risks and Remedies (English & Malayalam)
14. Safe Travel by Bus
15. Safe Bus Driving
16. Safe Car Driving
17. Safety Precautions for Two-Wheeler Drivers
18. Safe and Responsible Parking
19. Traffic Control Devices
20. Don't find out the hard way…
21. Trains of thought- Use Extreme caution when crossing
22. Trains of thought- Safety Slogans - Just Think
23. Trains of thought- Safety Slogans - Just Think over these
24. Railway level Crossings- Safety Tips for Vehicle Drivers
25. Safe Crossing of Railway Tracks-Tips for Pedestrians and Cyclists
26. Railway Level Crossing- Safety Tips for School Buses
27. Railway Level Crossing- Safety Tips for Truck drivers
28. സുരക്ഷിത ഇരുചക്രവാഹന സവാരി
29. രാത്രികാല റോഡപകടങ്ങൾ എങ്ങനെ ഒഴിവാക്കാം
30. സുരക്ഷിത യാത്രയ്ക്കുള്ള മാർഗനിർദ്ദേശങ്ങൾ
31. പ്രതിരോധാത്മക ഡ്രൈവിംഗ്

32. റോഡ് സുരക്ഷയും മുതിർന്ന പൗരന്മാരും
33. അമിത വേഗതയും അപകടസാധ്യതകളും
34. സുരക്ഷിത പാർക്കിംഗ്
35. സുരക്ഷിത ബസ് യാത്ര
36. ബസ് യാത്രയിൽ/കാൽനടയാത്രക്കാർ
37. ഡ്രൈവർമാർ/അമിത വേഗത
38. സ്ക്കൂട്ടർ/മോട്ടോർ/ഹെൽമെറ്റ് ധരിക്കൂ
39. മൊബൈൽഫോൺ/സീറ്റ് ബെൽറ്റ്
40. ആട്ടോറിക്ഷയിൽ/മദ്യപിച്ച്
41. റോഡിൽ എങ്ങനെ സുരക്ഷിതരാകാം

Display Boards

1. Railway Level Crossing – Safety Tips for Vehicle Drivers
2. Railway Level Crossing – Safety Tips for Pedestrians and Cyclists
3. Do not play near Track
4. Safety at Railway Level Crossing
5. Trains of thought
6. Railway Level Crossings Safety Tips
7. Safety Rules while waiting at Railway Stations
8. Indian Railways at your Service
9. Indian Railways- Lifeline of the Nation
10. Precautions for Bicyclists around Tracks
11. Precautions for Pedestrians
12. Children Safety around tracks
13. Take care at Crossings
14. Precautions at Crossings
15. Never Try to Beat a Train
16. Railway Level Crossing Signs
17. Safe Crossing of Railway Tracks
18. Know and Remember
19. തീവണ്ടിയെകുറിച്ചുള്ള ചില ചിന്തകൾ
20. റെയിൽവെ ലെവൽ ക്രോസ്സിംഗ് സുരക്ഷാ സൂചനകൾ
21. റെയിൽവെ സ്റ്റേഷനിൽ കാത്തു നിൽക്കുമ്പോൾ പാലിയ്ക്കേണ്ട സുരക്ഷാ നിയമങ്ങൾ
22. നിങ്ങളുടെ സേവനം ഇന്ത്യൻ റെയിൽവേയുടെ ലക്ഷ്യം
23. ഇന്ത്യൻ റെയിൽവെ രാജ്യത്തിന്റെ ജീവനാഡി
24. സുരക്ഷിതമായി റെയിൽപ്പാത മുറിച്ചു കടക്കൽ
25. അറിയൂ ! ഓർമ്മിക്കൂ !

Road Safety Posters

1. പത്തിനും പതിനഞ്ചിനും ഇടയ്ക്ക് വയസ്സുള്ള കുട്ടികൾക്ക് വേണ്ടി രക്ഷിതാക്കൾക്ക് എന്തു ചെയ്യാം1
2. പത്തിനും പതിനഞ്ചിനും ഇടയ്ക്ക് വയസ്സുള്ള കുട്ടികൾക്ക് വേണ്ടി രക്ഷിതാക്കൾക്ക് എന്തു ചെയ്യാം2
3. അഞ്ചിനും പത്തിനും ഇടയ്ക്ക് വയസ്സുള്ള കുട്ടികൾക്ക് വേണ്ടി രക്ഷിതാക്കൾക്ക് എന്തു ചെയ്യാം1
4. അഞ്ചിനും പത്തിനും ഇടയ്ക്ക് വയസ്സുള്ള കുട്ടികൾക്ക് വേണ്ടി രക്ഷിതാക്കൾക്ക് എന്തു ചെയ്യാം2
5. അഞ്ചിനും പത്തിനും ഇടയ്ക്ക് വയസ്സുള്ള കുട്ടികൾക്ക് വേണ്ടി രക്ഷിതാക്കൾക്ക് എന്തു ചെയ്യാം3
6. റോഡ് മുറിച്ചു കടക്കുമ്പോൾ1
7. റോഡ് മുറിച്ചു കടക്കുമ്പോൾ2
8. റോഡ് മുറിച്ചു കടക്കുമ്പോൾ3

9. ചില റോഡ് സുരക്ഷാ പ്രവർത്തനങ്ങൾ1
10. ചില റോഡ് സുരക്ഷാ പ്രവർത്തനങ്ങൾ2
11. ആട്ടോറിക്ഷയിൽ സഞ്ചരിക്കുമ്പോൾ ശ്രദ്ധിക്കേണ്ട കാര്യങ്ങൾ1
12. ആട്ടോറിക്ഷയിൽ സഞ്ചരിക്കുമ്പോൾ ശ്രദ്ധിക്കേണ്ട കാര്യങ്ങൾ2
13. റോഡ് സുരക്ഷയെ കുറിച്ച് അറിഞ്ഞിരിക്കേണ്ട മറ്റ് കാര്യങ്ങൾ1
14. റോഡ് സുരക്ഷയെ കുറിച്ച് അറിഞ്ഞിരിക്കേണ്ട മറ്റ് കാര്യങ്ങൾ2
15. നിങ്ങളും റോഡ് സുരക്ഷിതത്വവും 1
16. നിങ്ങളും റോഡ് സുരക്ഷിതത്വവും 2
17. ക്രോസിംഗ് ഡ്രിൽ 1
18. ക്രോസിംഗ് ഡ്രിൽ 2
19. യാത്ര ചെയ്യുമ്പോൾ ശദ്ധിക്കേണ്ട കാര്യങ്ങൾ
20. സിഗ്നൽ ലൈറ്റുകൾ
21. സൈക്കിൾ സവാരി ചെയ്യുമ്പോൾ
22. റോഡിൽ നടക്കുമ്പോൾ
23. Protect your life with seat belt and helmet
24. സുരക്ഷിതമായി ബസ്സിൽ യാത്ര ചെയ്യുന്നതിന് ചില നിർദ്ദേശങ്ങൾ
25. സിഗ്നൽ ലൈറ്റുകൾ കാൽനടയാത്രക്കാരുടെ ശ്രദ്ധയ്ക്ക്

INFRASTRUCTURE

1. Testing Facilities and Equipments

NATPAC is well equipped with the state of the art equipments for testing of highway materials, pavement evaluation and mix design. There is also a Geotechnical Lab for soil testing with all the equipments for routine testing of soil. The Traffic Engineering Lab of NATPAC is equipped with several softwares used for traffic modelling and analysis.

The Environmental Lab services provide air quality monitoring, noise level measurement and measurement of meteorological parameters. The list of equipments/softwares available with NATPAC is given below:

Sl. No.	Item
a) Highway Engineering Laboratory	
I.	**Soil Testing Equipments**
1.	Soil sieves
2.	Mechanical sieve shaker(motorized)
3.	Liquid limit test apparatus
4.	Shrinkage limit test set
5.	Compaction test equipment-light & heavy
6.	Automatic motorized universal compactor
7.	Core cutter for field density test
8.	Sand pouring cylinder (10cm,15 cm&20 cm dia) for field density test
9.	CBR test equipment
10.	Rapid moisture content - Infrared moisture meter
11.	Rapid moisture content - Calcium carbide test apparatus
12.	Post hole auger
13.	Direct Shear Test
14.	Triaxial Shear Test
15.	Unconfined Compression Test
16.	Consolidation Test
17.	Permeability Test
18.	Combined soil quality measurement instrument
19.	IS Sieve set for soil classification
II.	**Aggregate Testing Equipments**
20.	Aggregate sieves
21.	Aggregate Impact Value test equipment

22.	Los angles abrasion testing machine
23.	Stripping value test equipment
24.	Specific gravity test - Density basket
25.	Shape test - Thickness gauge & Length gauge, Angularity number test mould
III.	**Bitumen & Emulsion**
26.	Penetration test equipment
27.	Flash & fire point Test apparatus
28.	Softening point test - Ring & ball apparatus
29.	Ductility testing machine
30.	Standard Tar Viscometer
31.	Specific gravity - Pycnometer
32.	Dean and Stark apparatus - water content
33.	Distillation test apparatus
34.	Wax content test apparatus
35.	Solubility test equipment
36.	Particle charge test apparatus - emulsion
37.	Residue on 600 micron sieve test apparatus - emulsion
38.	Coagulation test apparatus - emulsion
39.	Settlement test apparatus – emulsion
IV.	**Tests on Mixes**
40.	Marshall stability test equipment.
41.	Motorized centrifuge extractor
42.	Core cutting machine - (100mm dia. core bit)-undisturbed sampling of bituminous pavement.
V.	**Test on Pavement and Evaluation**
43.	Fifth Wheel type Bump Integrator
44.	MERLIN - Machine for evaluating roughness using low cost instrumentation
45.	Benkelman beam test equipment
46.	Portable wheel weigh bridge/pad
47.	Portable Skid Resistance Tester
48.	Sand Patch method test set
49	Wheel Rut Tester
b) Traffic Engineering Laboratory	
50.	Noise level meter
51.	Speed Radar
52.	Distometer

c) Topographic Survey	
53.	DGPS
54.	Single Frequency GPS-5 Nos.
55.	Total stations-3 Nos.
56.	Automatic levels-2 Nos.
57.	Theodolite
58.	High end plotters -2 Nos.
59.	Electronic Total Station
d) Environment Laboratory	
60.	CO Analyzer
61.	CO_2 Analyzer
62.	NO_2 Analyzer
63.	CH_4 Analyzer
64.	Cup Anemometer
65.	Wind vane
66.	Wind logger
67.	RH meter
68.	Thermo couple sensor
69.	Spectro photo meter
70	Respirable Dust Sampler (APM 460)-2 Nos.
e) Water Transport Laboratory	
71.	Echo sounder
72.	Portable canti lever scale
73.	Distometer
f) General Accessories for Laboratory	
74.	Thermostatically controlled drying oven 0-150^{0}C
75.	Thermostatically controlled water bath
76.	Electronic balances – 200 g, 2 kg, 50 kg
77.	Soaking tank
78.	Heater
79.	Semiautomatic balance 10 kg – 2 nos.
80.	Traffic safety appurtenances
81.	Power generator- 2 nos.
82.	External car battery-3 nos.
83.	Digital Thermometer
84.	Agg plus for Corelok device
85.	Fall cone penetrometer
86.	Dynamic cone penetrometer

87.	UCC moulds
88.	Dial gauges
89.	pH meter
90.	Conductivity meter
91.	Turbidity meter
92.	DO meter
93.	Electronic balance (0.0001g accuracy)
94.	vacuum pump and hot plate
g) Application Softwares	
95.	MX ROAD
96.	AUTO CAD
97.	ARC GIS
98.	3DS MAX
99.	TALLY
100.	STADD PRO
101.	HDM IV
102.	SPSS
103.	ERDAS

2. *Library and Information Services*

The NATPAC Library is endowed with the responsibility of providing assistance to the scientists, researchers and students in their scientific and academic activities. The Library continued to cater to the information needs of the institute and students. The Library has a vast collection of books on Transportation, Traffic Engineering, Transport Economics, Urban and Regional Planning, Water Transport, Environment, Management, Operations Research, Geography, Statistics and allied subjects. The Technical Reports prepared by NATPAC are also available for reference purpose. The library has a good collection of the publications by Indian Roads Congress (IRC) and this collection is being updated regularly. A number of new journals, both National and International, have been added to the library during this year.

An in-house database of books, periodicals, bound volumes of journals, reports, etc., is being updated. NATPAC library is automated and managed using LIBSOFT. Bibliographic records of books available in the library can be accessed through Online Public Access Catalogue (OPAC).

The major services rendered to users by the library are reference service and literature search. Clippings from newspapers, web resources, etc. are maintained in the library for the benefits of users. E-mail alerts are sent to scientists and technical staff for new arrival of books and publications. NATPAC has been extending academic support and other R&D facilities to Researchers as well as Professionals to carry out their research and project works. During this year many Research scholars / students from different institutions undertook project works using the facilities available in NATPAC library.

Students and Research Scholars visited the library from various institutions like Rajiv Gandhi Institute of Technology, Kottayam; National Institute of Technology, Calicut, Kozhikode; Saintgits College of Engineering, Kottayam; Nehru Yuva Kendra, Kollam; School of Planning and Architecture, Bhopal; College of Engineering, Trivandrum; ITS Planners and Engineers, Hyderabad; Baselios Mathews College of Engineering, Sasthamcotta; Mar Baselios College of Engineering, Thiruvananthapuram; Sree Buddha College of Engineering for Women, Pathanamthitta; University College, Trivandrum; Al Azhar College Of Engineering and Technology (AACET), Thodupuzha; Sarabhai Institute of Science and Technology (SIST), Vellanad; Mar Baselios Christian College of Engineering and Technology, Kuttikanam; Mahatma Gandhi College, Trivandrum; Marian Engineering College, Trivandrum etc.

ORGANISATION

National Transportation Planning and Research Centre (NATPAC) is an Institution of Kerala State Council for Science, Technology and Environment, which is fully supported and funded by Government of Kerala.

I. KERALA STATE COUNCIL FOR SCIENCE, TECHNOLOGY AND ENVIRONMENT

i. The Members of the State Council consist of the following:

1.	Chief Minister of Kerala	-	President
2.	Minister for Industries, Govt. of Kerala	-	Vice President
3.	Minister for Finance, Govt. of Kerala	-	Vice President
4.	Minister for Agriculture, Govt. of Kerala	-	Vice President
5.	Minister for Health & Family Welfare, Govt. of Kerala	-	Vice President
6.	Minister for Education, Govt. of Kerala	-	Vice President
7.	Minister for Forests, Govt. of Kerala	-	Vice President
8.	Minister for Water Resources, Govt. of Kerala	-	Vice President
9.	Vice Chairman, State Planning Board, Kerala	-	Vice President
10.	The Chief Secretary to Government of Kerala	-	Vice President
11.	The Executive Vice President, KSCSTE	-	Member
12.	The Secretary, Department of Science and Technology, Government of India	-	Member
13.	The Secretary to Government, Finance Department, Govt. of Kerala	-	Member
14.	The Secretary to Government, Planning and Economic Affairs Department, Govt. of Kerala	-	Member
15.	The Vice Chancellor, Cochin University of Science and Technology	-	Member
16.	The Vice Chancellor, Kerala Agricultural University	-	Member
17.	The Director, Vikram Sarabai Space Centre, Thiruvananthapuram	-	Member
18.	The Director, NIIST, Thiruvananthapuram	-	Member
19.	The Director, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram	-	Member
20.	The Member Secretary , KSCSTE (nominated by Government)	-	Member
21.	Director, JNTBGRI, Trivandrum	-	Member
22.	Director, KFRI, Peechi, Thrissur	-	Member

Five eminent persons nationally known for their expertise in S&T, Industry and Environment (nominated by Government).

ii. Executive Committee of KSCSTE

1.	Executive Vice President (Ex-officio)	-	Chairman
2.	Secretary, Department of Science & Technology, Government of India or his/her nominee (Ex-officio)	-	Member
3.	Secretary, Planning & Economic Affairs, Government of Kerala (Ex-officio)	-	Member
4.	Additional Chief Secretary, Finance, Government of Kerala (Ex-officio)	-	Member
5.	Director, JNTBGRI, Trivandrum	-	Member
6.	Director, KFRI, Peechi, Thrissur	-	Member
7.	One representative each of Science and Technology, Industry and Environment Departments nominated to the Council by Government of Kerala	-	Member
8.	Member Secretary, KSCSTE	-	Member

iii. Research Council of NATPAC

1.	Prof. (Dr.) Veeraraghavan Department of Civil Engineering, IIT, Chennai	-	Chairman
2.	Prof. (Dr.) Tom Mathew Department of Civil Engineering, IIT Mumbai	-	Member
3.	Sri.R M Nair Formerly Member (Tech.) IWAI	-	Member
4.	Dr. Chandra Satish Department of Civil Engineering IIT Roorkee	-	Member
5.	Director, Technical Education Department Government of Kerala	-	Member
6.	Principal Secretary to Government Transport Department, Government of Kerala	-	Member
7.	Director, NATPAC	-	Member & Ex-Officio Convener

iv. Management Committee of NATPAC

1.	Director, NATPAC	-	Chairperson
2.	Director, KSCSTE	-	Member
3.	Director, JNTBGRI	-	Member
4.	Shri. D Robinson, Scientist –F, NATPAC	-	Member
5.	Smt. L Geetha, Additional Secretary to Govt., GoK	-	Member
6.	Registrar, NATPAC	-	Member

v. ***Information Officers as per the Right to Information Act***

Public Information Officers	-	Shri D.Robinson Sr.Principal Scientist *(Technical Matters)* Shri K Mohanakumar Deputy Registrar (Finance) *(Administrative Matters)*
Asst. Public Information Officer	-	Smt T S Sangeetha Assistant
Appellate Authority, RTI Act	-	Dr B G Sreedevi, Director

vi. ***Internal Committees***

a. ***Library Committee***

Shri D Robinson, Scientist – F	-	Chairman
Shri Shaheem S, Scientist – E1	-	Member
Shri V S Sanjay Kumar, Scientist – E1	-	Member
Shri Arun Chandran, Scientist-C	-	Member
Smt K S Veena, Scientist – B	-	Member Convenor

b. ***Purchase Committee***

Shri D Robinson, Scientist – F	-	Chairman
Shri K Mohana Kumar, Deputy Registrar	-	Member
Shri S Shaheem, Scientist – E1	-	Member
Shri.Kalaiarasan, Scientist-C	-	Member

c. ***Grievance Redressal Committee***

Shri K George Koshy, Registrar	-	Chairman
Shri D Robinson, Scientist – F	-	Member
Shri K Mohanakumar, Deputy Registrar	-	Member
Shri T Ramakrishnan, Technical Officer V	-	Member
Shri K C Wilson, Scientist-C	-	Member
Smt. T S Sangeetha, Assistant Grade-1	-	Member-Convenor

d. ***Complaint Committee to prevent sexual harassment of working women at work place of NATPAC***

Smt PN.Salini, Scientist – C	-	Chairperson
Smt.R.Padmini Nair, Accounts Officer,VSSC (Retd)	-	Member

Shri M S Saran, Scientist-C	-	Member
Smt N M Sabitha, Scientist-C	-	Member
Smt Mayadevi, Assistant Grade -1	-	Member Convenor

e. Editorial Board

1. Annual Report	-	Director Registrar Shri.D Robinson, Scientist-F Smt.P N Salini, Scientist-C Smt.Veena, Scientist-B
2. Safe Savari	-	Director Shri.D Robinson, Scientist-F Shri.Subin B, Scientist –C Smt.Veena, Scientist-B Shri.Sanjai R J, Technical Officer – I
3.Mobility	-	Director Shri.D Robinson, Scientist-F Shri.T.Ramakrishnan, Techincal Officer- V Shri.Anish Kini, Scientist-B Smt.Veena, Scientist-B

f. Project Implementation Committee

Director	-	Chairperson
Registrar	-	Convenor
Deputy Registrar	-	Member
Shri.Shaheem, Scientist-E1	-	Member
Shri.Subin B, Scientist-C	-	Member

General Administration

Research Council Meeting

The 18th meeting of the Research Council was held on 22nd and 23rd April 2016 at NATPAC under the chairmanship of Prof. (Dr.) Veeraraghavan.

Management Committee Meeting

The Management Committee met on 14th October 2016 (30th MC) and 29th November 2016(31st MC) at NATPAC under the chairmanship of Director, NATPAC.

Other NEWS

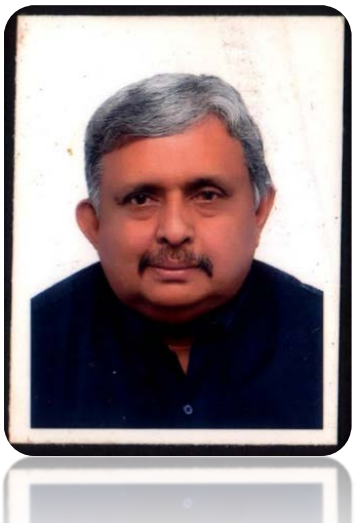
NATPAC and INDIMASI jointly organized a half day programme in connection with International Yoga Day on 21st June at K Karunakaran Transpark, Aakkulam. Guru Yogi Shiva, INDIMASI demonstrated on 'Health of Working Staff'.

NATPAC STAFF –AS ON 01.04.2017

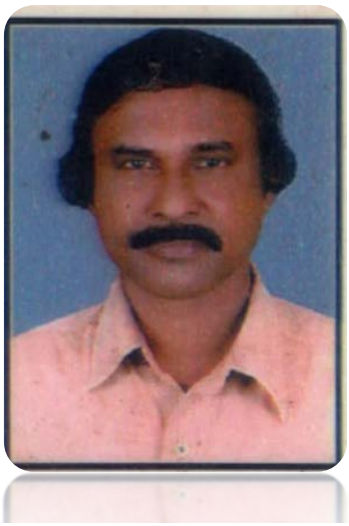
Sl.No.	Name		Designation
	Dr. B. G.Sreedevi	-	Director
Scientific Staff			
1.	D. Robinson	-	Senior Principal Scientist
2.	S.Shaheem	-	Principal Scientist
3.	V. S.Sanjay Kumar	-	Senior Scientist
4.	P.Kalaiarasan	-	Scientist
5.	B.Subin	-	Scientist
6.	P. N. Salini	-	Scientist
7.	M. S. Saran	-	Scientist
8.	N.M.Sabitha	-	Scientist
9.	K. C.Wilson	-	Scientist
10.	Arun Chandran	-	Scientist
11.	Veena K.S.	-	Jr. Scientist
12.	S. Ebin Sam	-	Jr. Scientist
13.	A. Jegan Bharath Kumar	-	Jr. Scientist
14.	R. Chandra Prathap	-	Jr. Scientist
15.	U. Salini	-	Jr. Scientist
16.	B. Anish Kini	-	Jr. Scientist
Technical Staff			
17.	K. M. Syed Mohammed	-	Principal Technical Officer
18.	T.Ramakrishnan	-	Technical Officer Grade -5
19.	V. G. Sasi	-	Technical Officer Grade -3
20.	M.S. Radhakrishnan	-	Technical Officer Grade -3
21.	K. Devadethan Nair	-	Technical Officer Grade -3
22.	E. P. Surendran Pillai	-	Technical Officer Grade -3
23.	R. J. Sanjai	-	Technical Officer Grade -1
24.	Deepa Radhakrishnan	-	Technical Officer Grade -1
25.	T.Mohan	-	Technical Assistant Grade-3
26.	S. Geetha	-	Technical Assistant Grade-3

27.	R. Radhakrishnan Thampi	-	Technical Assistant Grade-3
28.	Shyama C.	-	Jr.Library Assistant Grade-1
Administrative Staff			
29.	K.George Koshy	-	Registrar Grade - 2
30.	K. Mohanakumar	-	Dy. Registrar Grade - 1
31.	T. Vijayan	-	P.A. to Registrar Grade-4
32.	Abey George	-	P.A. to Director Grade-4
33.	D. Shaju	-	Section Officer Grade-1
34.	R. Lekha	-	Typist cum Stenographer Grade-5
35.	Arya S.K.	-	Assistant Grade – 1
36.	Maya Devi M.	-	Assistant Grade – 1
37.	Veena S.	-	Assistant Grade – 1
38.	Muhammed Naserudeen C.	-	Assistant Grade – 1
39.	Sangeetha T.S.	-	Assistant Grade – 1
40.	Lajila K.B.	-	Stenographer Grade – 1
41.	A.Praveen Kumar	-	Clerical Assistant Grade -2
42.	G.Ragesh	-	Driver Grade - 2
43.	A.Somaraj	-	Driver Grade - 2
44.	Surendran Kulangara	-	Driver Grade – 2
45.	Shijil P. R.	-	Driver Grade – 2
46.	Sukhdev Kolay	-	Jr. Assistant
47.	P. X. Mathew	-	Jr. Assistant
48.	S. Jayakumar	-	Helper Grade -5
49.	G. Suresh Kumaran Nair	-	Helper Grade -4
50.	A.Anil Kumar	-	Helper Grade -2
51.	Athira S.Kumar	-	Helper Grade -1

RETIREMENTS



Shri Tomy Cyriac
Scientist-F
Superannuated on
30th April 2016



Shri C Muraleedharan Pillai
Technical Officer Grade-5
Superannuated on 30th November 2016

Shri D Sunder
Principal Scientist
Superannuated on
31stMarch 2017

RESIGNATION

Shri Ramdas M
Stenographer Grade - 1
Resigned on
13th December 2016

RESEARCH STUDIES UNDERTAKEN DURING 2016-'17

Sl.No.	Code	Project
1	Plan-228	Study on the performance of Highway Development Projects in Kerala
2	Plan-229	Study on conservation of natural resources by recycling of Asphalt Pavements
3	Plan-230	Strategic Plan for the development of National Highway Network in Kerala
4	Plan-231	Development of Traffic Growth Rate Model for NHs in Kerala
5	Plan-232	Mitigation measures for reducing Pedestrian Related Accidents in selected roads
6	Plan-233	Investigation of Major Accident Spots and Accident Causative Analysis & Mitigate Measures
7	Plan-234	Periodic Updation of Price Indices for different Public Transport and Freight Operations
8	Plan-235	Assessment of Risk Potential of SH in Kerala State using iRAP Methodology: a Case Study of Adoor – Chengnnoor stretch of MC Road
9	Plan-236	Cost of Road Accidents in the state of Kerala – Alappuzha District
10	Plan-237	Evaluation and Optimization of Auto Rickshaw Operations in Thiruvananthapuram City
11	Plan-238	A Comparative Study of Road Safety Activities in Malabar Region of Kerala
12	Plan-239	Study on the Collapse Behavior of Compacted Soil in Highway Embankment
13	Plan-240	Use of Waste Plastic in the Subgrade Layer of Flexible Pavement
14	Plan-241	Study on use of Construction Waste Materials for Sub-base and Base Layers of Flexible Pavements
15	Plan-242	Study on the Development of Feeder Routes for Light Rail Transit System in Thiruvananthapuram
16	Plan-243	Integration of Multi-model Transit System for Urban Areas – A case study of Kochi City
17	Plan-244	Preparation of Comprehensive Mobility Plan for Medium Sized Cities in Kerala
18	Plan-245	Black Spot Determination of Traffic Accident Locations and its Spatial Association Characteristic Analysis Based on GIS
19	Plan-246	Development of GIS-based Road and Traffic Database for Kerala
20	Plan-247	Technical Feasibility Study on Ro-Ro Operations in Vembanad lake at North and South of Thanneermukkom
21	Plan-248	Development of Air Pollution Index of Kerala
22	Plan-249	Study on Accidents and Safety Aspects related to Inland waterways
23	Plan-250	Database Creation and Management for Inland Waterways in Kerala using GIS – Phase I
24	Plan-251	Study on Formulation of Toll Pricing in Kerala
25	Plan-252	Estimation of Trip Generation Rates for Different Land Uses
26	Plan-253 - 1	Investigation and Design of Porous Asphalt Mix for Kerala Region
27	Plan-253 - 2	Thiruvananthapuram Airport – NH 66 access: Options and Issues

28	Plan-253 - 3	Development of parallel Taxi Parking Area in Thiruvananthapuram International Airport
29	Plan-253 - 4	Road Safety Assessment in various road stretches in Kanjirapally
30	Plan-253 - 5	Road Safety measures for Road Section from Kottamukku junction to Kovalam Road
31	Plan-253 - 6	Feasibility study for the Development of Coastal Highway in Kerala
32	Plan-253 - 7	Prioritization of Links in Hill Highway for Preparation of DPR

CONSULTANCY/SPONSORED PROJECTS IN 2016-'17

Sl.No.	Code	Project	Sponsored by
1		Guidelines of bus stations/bus stops	
2	C 00116	Signage scheme for Karamana River area in Trivandrum City	KSCSTE
3	C 00216	Design of implementation of Road Safety and Traffic Management Schemes for selected road stretches in Gurgaon	
4	C 001215	Traffic and Transportation Studies for 11 Towns	Department of Town and Country Planning, GoK
5	C 00616	Verification of Topographic Survey	Kerala Sustainable Urban Development Project (KSUDP)
6	C 01213	Preparation of DPR bus procurement.	
7	C 00916	Preparation of pavement design of Ambalappuzha - Triruvalla Road	
8	C 00316	DFIP – Improvement and upgradation of Nadukani– Vazhikadavu–Nilambur – Edavanna – Manjeri – Malapuram – Vengara – Tirurangadi- – Parappanangadi road in Malappuram District	
9	RP 00515	Identification and Prioritization of accident black-spots in Ernakulam district	
10	C 00416	Consultancy services for Market Research for Publicity and Education Programme – Helmet Wearing and Helmet Usage	
11		Testing of bituminous mix modified with zychotherm	
12		Improvement of Intersections in Nadukani-Parappanangadi road in Malappuram	
13	C 00716	Rebuilding Alappuzha – Preparation of concept report	
14	C 00816	Feasibility Study and Preparation of DPR for development of canals in Kochi	Kerala Shipping and Inland Navigation Corporation Ltd. (KSINC)
15	C 01516	Operational Road Safety Audit from Varapuzha Bridge to Moothakunnam Junction on National Highway-66	

16		Feasibility of Widening Existing Flyover and Constructing new Flyover at Thampanoor in Thiruvananthapuram City	
17	C 01316	Traffic Improvement Plan for Mele Chovva Junction	Municipal Corporation, Kannur
18	C 01416	Junction Improvement of Kunnamkulam	
19	C 01616	Traffic and Transportation study for 8 municipal towm	
20	C 00115	Training on Safe Transportation of Hazardous Goods	

Projects Sponsored by Kerala Road Safety Authority (KRSA) RP **00115**

i.	Safe Community Programme at Panchayath Level
ii.	Safe Road to School (SRS) Programme
iii.	Accident Surveys and Analysis
iv.	Impact of speed governors on the safety of heavy vehicles and fuel efficiency
v.	Level of compliance of seat belt usage in selected cities of Kerala
vi.	Development of GIS based Road Safety Data Base Management System
vii.	Application of Intelligent Transport Systems (ITS) for enhancing Road Safety in Kerala
viii.	Accident Reconstruction Studies of Selected Fatal Accidents
ix.	Pedestrian crossing and vehicle conflicts – A case study of selected road stretches in Malabar Region
x.	Road Safety Workshop, Seminars and Training Programmes for drivers, public, traffic police, driver training colleges etc.
xi.	Production and free distribution of Road Safety Education/Awareness Materials like: Films, Road Safety Education Books and Leaflets, Sticker, Badges, Calenders, Display Boards, Banners etc.
RP 00315	Teachers Training Programme – Phase II

NATIONAL TRANSPORTATION PLANNING AND RESEARCH CENTRE, TRIVANDRUM

(A unit of Kerala State Council for Science, Technology & Environment. Govt. of Kerala)

Balance Sheet as on 31st March 2017

Liabilities	Sch No	As at 31.03.2017	As at 31.03.2016	Assets	Sch No	As at 31.03.2017	As at 31.03.2016
Reserves & Surplus	4	1,81,18,721	1,77,14,973	Fixed Assets	1	1,81,18,721	1,77,14,973
Current Liabilities	5	53,99,573	52,23,839	Current Assets	2	15,90,41,607	12,12,43,593
Unspent balance	6	14,53,55,988	11,02,95,245	Loans & Advances	3	9,87,53,553	9,45,15,090
Building Fund Account	4	10,70,39,600	10,02,39,600				
Total		**27,59,13,881**	**23,34,73,656**	**Total**		**27,59,13,881**	**23,34,73,655**

For Mohan & Mohan Associates
Chartered Accountants

R. Suresh Mohan
Partner
Membership No. : 013398
Firm Reg. No.: 002092S

Place : Thiruvananthapuram
Dated :

For National Transportation Planning and Research Centre
Trivandrum

(Dy Regstrar) (Finance)

(Regstrar)

(Director)

SHIBU. A.T
Deputy Registrar (Admin) &
Deputy Registrar (Fin) i/c

Place :Thiruvananthapuram
Dated:

NATIONAL TRANSPORTATION PLANNING AND RESEARCH CENTRE, TRIVANDRUM
(A unit of Kerala State Council for Science, Technology & Environment. Govt. of Kerala)
Income & Expenditure Account for the year ended 31/03/2017

Expenditure	Sch No	Year ended 31.03.2017	Year ended 31.03.2016	Income	Sch No	Year ended 31.03.2017	Year ended 31.03.2016
		₹	₹			₹	₹
To Infrastructure Strengthening (Plan)	10	1,65,05,577	1,74,06,755	By Grant from Government of Kerala	7	3,34,72,804	5,76,63,978
To Infrastructure Strengthening (Non Plan)	11	73,01,484	45,11,375	By Other Receipts	8	3,53,63,741	74,22,146
To Salaries and Allowances (Plan)	12	-	-	By Depreciation written back	1	40,97,755	39,80,123
To Salaries and Allowances (Non Plan)	13	4,50,29,484	4,31,67,993	By Income from Consultancy Project	9	1,80,02,781	1,81,50,454
To Depreciation	1	40,97,755	39,80,123				
To Consultancy Project Expenses		1,80,02,781	1,81,50,454				
Total		**9,09,37,081**	**8,72,16,700**	**Total**		**9,09,37,081**	**8,72,16,700**

For Mohan & Mohan Associates
Chartered Accountants

R. Suresh Mohan
Partner
Membership No. : 013398
Firm Reg. No.: 002092S

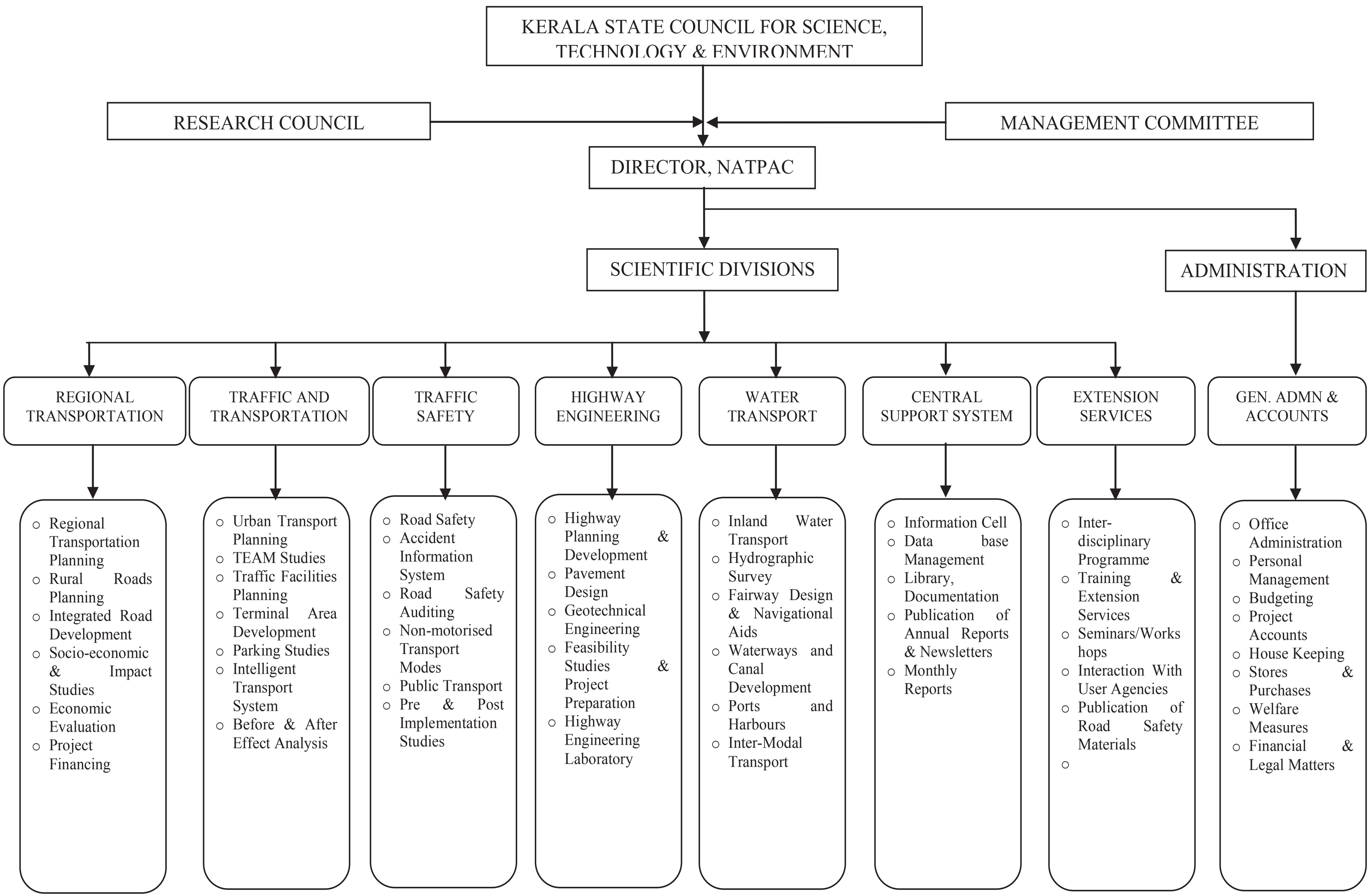
Place : Thiruvananthapuram
Dated :

For National Transportation Planning and Research Centre
Trivandrum

(Dy Regstrar) (Regstrar) (Director)

SHIBU. A.T
Deputy Registrar (Admin) &
Deputy Registrar (Fin) i/c

Place :Thiruvananthapuram
Dated:


KERALA STATE COUNCIL FOR SCIENCE, TECHNOLOGY & ENVIRONMENT
RESEARCH COUNCIL
MANAGEMENT COMMITTEE
DIRECTOR, NATPAC
SCIENTIFIC DIVISIONS
ADMINISTRATION
REGIONAL TRANSPORTATION
Regional Transportation Planning
Rural Roads Planning
Integrated Road Development
Socio-economic & Impact Studies
Economic Evaluation
Project Financing
TRAFFIC AND TRANSPORTATION
Urban Transport Planning
TEAM Studies
Traffic Facilities Planning
Terminal Area Development
Parking Studies
Intelligent Transport System
Before & After Effect Analysis
TRAFFIC SAFETY
Road Safety
Accident Information System
Road Safety Auditing
Non-motorised Transport Modes
Public Transport
Pre & Post Implementation Studies
HIGHWAY ENGINEERING
Highway Planning & Development
Pavement Design
Geotechnical Engineering
Feasibility Studies & Project Preparation
Highway Engineering Laboratory
WATER TRANSPORT
Inland Water Transport
Hydrographic Survey
Fairway Design & Navigational Aids
Waterways and Canal Development
Ports and Harbours
Inter-Modal Transport
CENTRAL SUPPORT SYSTEM
Information Cell
Data base Management
Library, Documentation
Publication of Annual Reports & Newsletters
Monthly Reports
EXTENSION SERVICES
Inter-disciplinary Programme
Training & Extension Services
Seminars/Workshops
Interaction With User Agencies
Publication of Road Safety Materials
GEN. ADMN & ACCOUNTS
Office Administration
Personal Management
Budgeting
Project Accounts
House Keeping
Stores & Purchases
Welfare Measures
Financial & Legal Matters

KSCSTE - National Transportation Planning and Research Centre

(An Institution of Kerala State Council for Science, Technology and Envioronment)
Sasthra Bhavan, Pattom - 695004, Thiruvananthapuram
Phone: 0471-2548200, Director: 2548300, Registrar: 2548310, Fax: 0471-2543677
E-mail: contactus.natpac@kerala.gov.in, Web: www.natpac.kerala.gov.in

KSCSTE - National Transportation Planning and Research Centre

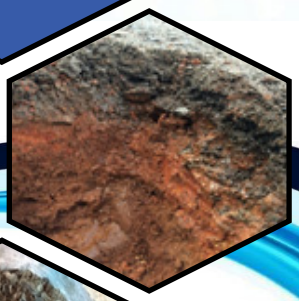
K. KARUNAKARAN TRANSPARK, Aakkulam,
Thuruvikkal P.O, Thiruvananthapuram, Pincode: 695031
Phone: 0471-2551282 / 2554467 / 2553701

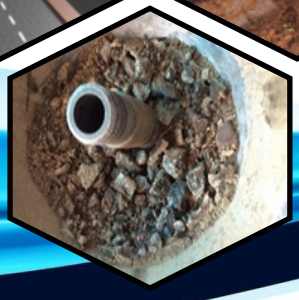
REGIONAL OFFICE (KOZHIKODE)
1/1076(c), Kanakalaya Bank Cross Road,
West Hill P.O, Kozhikode.
Pincode: 673005, Phone: 0495 - 2385505












natpac
KSCSTE-NATPAC

KSCSTE - National Transportation Planning and Research Centre

के एस सी एस टी इ – राष्ट्रीय परिवहन योजना एवं अनुसंधान

കെ എസ് സി എസ് ടി ഇ– ദേശീയ ഗതാഗത ആസൂത്രണ ഗവേഷണ കേന്ദ്രം

An Institution of Kerala State Council for Science, Technology and Envioronment
Sasthra Bhavan, Pattom - 695004, Thiruvananthapuram
Phone: 0471-2548200, Director: 2548300, Registrar: 2548310, Fax: 0471-2543677
E-mail: contactus.natpac@kerala.gov.in, Web: www.natpac.kerala.gov.in