

1. TRC15RP1_Experimental investigation on strength criteria of coir waste and lime treated softsoil

This work aims to study the effect of treatment of such a problematic soil, the marine clay, with a locally available waste material, the coir waste and a chemical stabilizer, the lime, in order to make it suitable for the construction of flexible pavements. Addition of optimum quantity of coir waste reduced the swell index by 82%, swell pressure by 87% and 3D swell strain by 42% while there was 21% decrease in 3D shrinkage strain. The addition of lime to the coir waste treated soil and the curing effect shows a strength improvement ratio in the range of 10 to 27. A design model was also developed to quantify this strength improvement in terms of lime content and curing period. The experimental and results indicate that coir waste can be used as a controlling material for volume change behaviour of soft soils and lime can be used for the strength improvement of coir waste treated soils.

2. TRC15 RP2_A Study on Automobile Air Pollution In Thiruvananthapuram City

Air pollution is a serious environmental problem faced by humanity worldwide. Road transport sector is a major factor affecting urban air quality. Kerala has been experiencing phenomenal growth in the number of vehicles during the past decade. According to the statistics released by the Motor Vehicles Department of Kerala, the motor transport sector registered an annual growth rate of 10%. This in turn is resulting in degradation of air quality especially in urban centres. The present study assessed the ambient air pollutant concentration of five traffic intersections in Thiruvananthapuram city. PM_{2.5} concentration was observed to be higher than the NAAQS in four of the sampling stations and is posing serious health risk to the exposed population. The major contributors for HC, CO and NO₂ emission have been identified as two wheelers, three wheelers and buses respectively. Exhaust pollutants forecasted from this study can be used to develop control strategies for the abatement of vehicular pollution in the study area. It was also seen that diesel vehicles produce more emissions when compared to petrol vehicles. High concentration of CO and CO₂ is found in the emissions analysed from different buses. The susceptibility of plants to vehicular pollution was studied based on APTI. Based on the biochemical characteristics the susceptibility of fifteen plant varieties to vehicular pollution was studied. *Anacardium occidentale*, *Ixoracoccinea* and *Polyalthia longifolia* were identified as tolerant

varieties in the station exposed to vehicular pollution. Hence these plants species can be effectively used for the development of green belt in the study area.

Studies in the area of traffic related air pollution in the city are very rare. The present study has generated a baseline data which would be helpful in proper traffic management of the city. Observations from this study are highly helpful in realising one of the serious problems affecting human health and is beneficial for the govt. authorities in taking suitable mitigatory measures. Even though the current status of concentration of gaseous pollutants is within the limit, it is necessary to adopt suitable measures to prevent further increase in the future. Further studies are required for evaluation of air quality status of other traffic intersections of Thiruvananthapuram city. The health risks of high PM_{2.5} concentration to which the population of the study area is exposed need to be monitored continuously. An integrated strategy needs to be developed for the abatement of vehicular pollution in the study area.

3. TRC15RP5_ Investigation on Structural and Geological aspects of Road aggregates and their impact on Performance of Road mixes

Quality control is an absolute necessity for building long lasting roads. Selecting source of building materials is an essential part of quality control. These materials and the mix prepared are subjected to adverse traffic and climatic conditions. Hence a thorough study on the impact of composition of the rocks and weather on the performance of mixes was necessary. The overall objective of the study was to map the sources of road aggregates and to explore avenues of application for waste aggregates from stone industry in pavement mixes. Stone aggregate samples were collected from five quarries in Thiruvananthapuram (Fig. 1), and laboratory tests were conducted. It was observed that minerals influence the strength and durability of stone aggregates.

On the basis of field investigations, petrographic and systematic analysis of structural elements, the following conclusions can be drawn. The physical characteristics such as density, natural moisture content, specific gravity, porosity, water absorption etc. of the study area rocks were investigated and Charnockite rock emerged out as the best rock with favourable properties for construction purpose. Charnockite has the greatest density and specific gravity and least porosity and water absorption. Hence with these properties, it can be reliably used for construction purposes.

To test the suitability of the rocks for use in road work applications, the important properties

tested include hardness, crushing strength and durability. Once again Charnockite led the Garnetiferous Biotite Gneiss rocks by considerable margin. The petrographic investigation of study area rocks included determination of mineral composition and texture. The favourable properties of Charnockite compared to GBG can be attributed to the presence of dominant mafic (Hypersthene) in Charnockites which are intrusive without any preferred orientation. They have been subjected to granulite facies of metamorphism at ultra-high temperatures and pressures. The former properties, structure and texture of the rock completely changes at those conditions. The rocks melt and get thoroughly churned. The existing faults, veins, cracks, joints etc. vanish and new ones form when the rock later crystallise with quite different properties. The other rocks GBG have not been subjected to high grade metamorphism. Hence they show their former properties without much change due to metamorphism.

There is only a marginal difference in durability, but the slake durability tests does not simulate worst field conditions. A combination test like *Cantabro* test is to be conducted on mix specimens to simulate near realistic field situations and assessments are then to be made on durability of mixes. It was noticed that like in slake durability, the adhesivity values are close to 100, with only marginal differences. But the slightest reduction in adhesivity can initiate stripping which is detrimental to the performance of pavements.

Marshall stability test reveals that, among the six types of aggregates, bituminous mixes prepared with basalt has maximum strength and bituminous mixes prepared with GBG has the least strength. Optimum binder content is least for Marble. All the six type of aggregates have Tensile Strength Ratio (TSR) more than 80 % which is the minimum required. Among the aggregate types available, Marble has the highest TSR of 91.67 % and sandstone has the lowest TSR of 83.72 %.

Bituminous mix with basalt has more rut resistance and bituminous mix with GBG has least rut resistance. Bituminous mix with basalt has a rut depth of 1.23 mm while bituminous mixes with GBG has a rut depth of 3.87 mm after 2520 passes. Basalt was found to be the most suitable rock in terms of its ACV (26.79%), soundness (1.95% in magnesium sulphate and 0.7% in simulated rainwater), stripping (0 %), Marshall Stability value (19.5 KN) and optimum bitumen content (5.6%). As the percentage of replacement of fine aggregate fraction of charnockite increases from 25% to 100%, strength of bituminous mix replaced with marble, basalt and sandstone increases by 17.21%, 10.29% and 15.45% respectively. Strength of bituminous mix replaced with granite and GBG decreases by 13.21% and 9.94% respectively.

When compared to Charnockite, fine aggregate of marble, basalt and sandstone have more strength. Granite and GBG when used as fine aggregate give low strength. Among the three pairs, marble – sandstone pair has the highest Marshall stability value and Charnockite – GBG pair has the least stability value. Marble – sandstone pair has slightly more stability value when compared to individual marble and sandstone mixes. Basalt – Granite pair reduces the Optimum Binder Content when compared to individual basalt and granite mixes.

Quarry information system has been developed by incorporating the thematic maps developed by using GIS, the data collected by field investigation and the results obtained through testing of aggregates and minerals. Quarry database for Trivandrum Corporation were developed which will provide information about the location of quarries, aggregate properties and mineral properties of the quarry materials, accessibility of quarries. Accessibility evaluation was carried out by using ArcGIS Network Analyst Toolbar. Service area for each quarry and each road nodes were generated. Service area of quarries provides the information about the road stretches and areas that can be served from a single quarry based on the cost attribute. The service area generated for the road nodes provides information about various quarries from which quarry materials can be used for the pavement construction purpose of the selected road stretch. The analysis was based on cost attribute and ranking of quarries. Ranking of quarries was done based on the engineering and geologic evaluation of quarry materials.



(a)



(b)



(c)



(d)



(e)



(f)

Fig.1 Rock types selected for study (a) Charnockite, (b) GBG, (c) Sandstone, (d) Granite, (e) Marble and (f) Basalt

Deliverables:

- ✓ Comprehensive report on the engineering and geologic evaluation of aggregates.
- ✓ Development of a Quarry Information System.
- ✓ Accessibility evaluation report for quarries.

Societal Relevance:

- ✓ Improved road quality and longevity.

- ✓ Optimal utilization of local and waste materials.
- ✓ Sustainable development through the reuse of waste aggregates.

4. TRC15RP7 - Extraction of Urban Roads from High Resolution Satellite Images

This study proposed a methodology for automatic extraction of roads from high resolution satellite imagery. The method uses the GeoEye imagery of 0.46m spatial resolution.

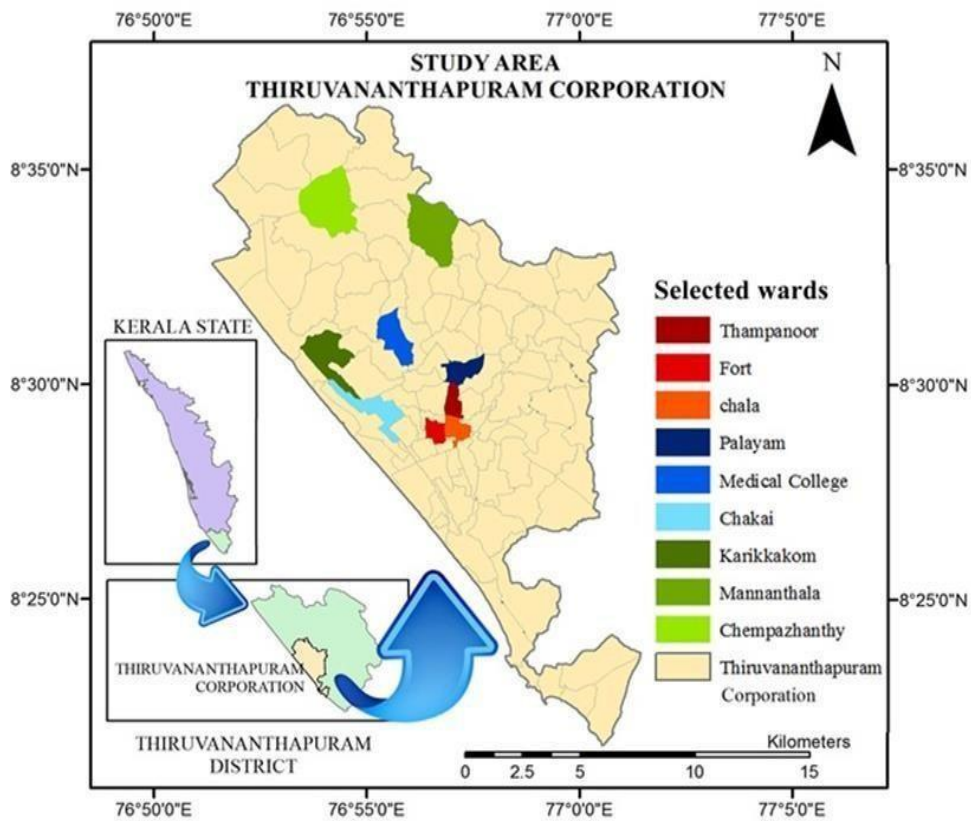


Fig.2 Study Area: Thiruvananthapuram Corporation