RESEARCH PAPER | Technology & Innovation | Volume : 4 | Issue : 4 | Special Apr Issue 2014 | ISSN - 2249-555X

# Effectiveness of Prefabricated Vertical Drains Over Conventional Sand Drains in Indian Railway Project

KEYWORDS: Railway line, constraints, soft clay, soil instability, perforated vertical drain

**K.VAIRAKANNU**
Final Year M.Tech, Department of Civil Engineering, Periyar Maniammai University, Vallam, Thanjavur

**Dr.R JAYANTHI**
Director, Centre for Climate change, Periyar Maniammai University, Thanjavur

**ABSTRACT** *The construction industry in India has grown tremendously with technological advancement in large number of mega projects in roads, railways, urban infrastructure, ports, Airports, space research and renewable energy sources. Due to the massive urbanization infrastructure development along the coastal belt experiences a compulsion to utilize the soft clays as foundation for road networks, ports and rail road. The consolidation settlement of soft clay subsoil creates a lot of problems in foundation and infrastructure engineering. Because of the very low clay permeability, the primary consolidation takes a long time to complete. To shorten this consolidation time, vertical drains are installed together with preloading by surcharge embankment or vacuum pressure. This study takes a specific case in construction of proposed broad gauge line from Nagappattinam to Thiruthuraipoondi along the east coast line in Tamilnadu where the coastal belt contains soft clay deposit needs to stabilize before commencement of the project. The advantages of using perforated vertical drain over the conventional sand drains are also discussed.*

## INTRODUCTION

In India infrastructure projects on railways, Highways and airways has a wide spread improvement using latest technology and construction management. In spite of technological knowhow, planning using construction management technique is still lacking. In this project major constraints are the poor bearing capacity of soil and requires soil stabilization before the commencement of the project. In addition to this huge quantity of material for bund formation like earth and sand is scarce now.

The above said constraints are to be analyzed and finding the alternative solution in the planning stage is the appropriate method of approach. After the commencement of the project, identification of constraints requires additional time and cost. Based on the economical, ease of installation and environmental feasibility the recommendations can be made on Perforated Vertical Drains for Soil Stabilization. Procurement of earth can be done by de silting of ponds, new percolation ponds and identification of new storage reservoirs. In this regard the quarry site should be of minimum lead.

## STUDY AREA

For the present study, the area has been selected from Nagappatinam to Thiruthuraipoondi railway line construction project in Nagappatinam Thiruvarur districts of Tamilnadu state in India. Nagappatinam (10.7700 deg N, 79.8300deg E) is one of the biggest towns in Tamilnadu and is situated in the Middle East of the State. It is also an important station. Thiruthuraipoondi (10.5273deg N, 79.6328 deg E) is an existing junction station at km: 64.02 (from Mayiladturai) on Villupuram – Thanjavur section. Thiruthuraipoondi is one of the largest towns in Tamilnadu and is situated in the middle East of the State. It is also a Junction for the Railways on Meter Gauge for the Thiruthuraipoondi – Agastiyampalli branch line.


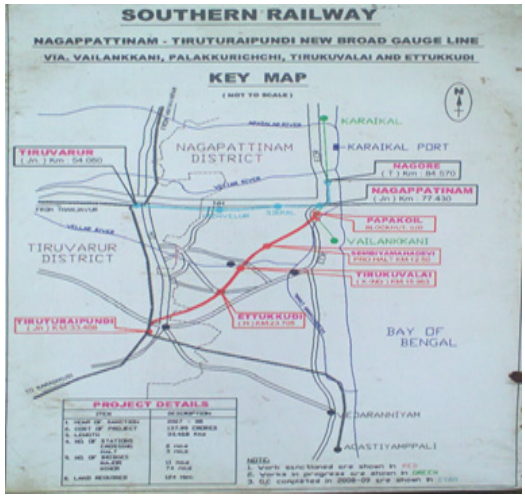


**Fig 1.1 Schematic Representation of the Study Area**

Volume : 4 | Issue : 4 | Special Apr Issue 2014 | ISSN - 2249-555X

**DETAILS OF THE PROJECT**

A new B.G line between Nagappatinam and Thiruthuraipoondi via Thirukkuvalai was nctioned at an estimated cost of Rs. 300 Crores. Though the survey was ordered to take off from Nagapattinam, already a existing B.G line from Nagapattinam to Velankanni. From this line the proposed alignment will take off from km: 3.00(from Nagapattinam) near Papakoil village, there was proposed a new block hut station called as Papakoil and covers Palakkurichi and Thirukkuvalai at a total length of 33.468 Kms.

**Geographical Features**

The proposed railway line will serve Nagapattinam and Thiruvarur districts of Tamilnadu State. The entire alignment is running in plain section. Due to some major bridges, earthwork in filling 7m is also necessary here. The proposed alignment has to cross the important rivers Kaduvoiyar, Sulliayar, Pandavaiya, Vellar,Harchandranadi and Adapar. Major part of the alignment is in wet lands.

The topo sheets to scale 1: 50000 are obtained from survey of India. A trial alignment was fixed based on obligatory points served by the particular alignment according to other site to fix the alignment and collect the other salient features. While selecting the alignment important rivers and road crossings and station sites were fixed first. Introducing smooth curves then joined these obligatory points. The present alignment now marked has been achieved after a number of trials made on the topo sheets.

**Salient Features**

The proposed site is near east coast and frequently affected by the natural calamities like cyclone and flood. The project area comprises in river Cauvery delta with fertile and cultivable. The belt receives rainfall during southwest monsoons with moderate intensity .Paddy is the main crop in the major area whereas dry crop is also cultivated in Nagappatinam district.

- Soil available in the project area is alluvial in nature which is transported through wind and water and deposited along coastal belt due the decrease in velocity of the transporting media.
- The new line shall be of group D category
- The alignment shall connect important population/ trade centers enrooted.
- The ruling gradient is 1 in 200 duly compensated for curvature at the rate of 0 .04 % per degree of curvature. Vertical cures shall be laid wherever they algebraic difference of change in grade is 4mm or more per meter. The gradients of the station yards are not steeper than 1 in 1200.
- The maximum degree of curvature is 3degrees in this section all curves shall be transitioned for a maximum permissible speed of 110 Km/hr.
- Land width shall be limited to the minimum prescribed in the engineering code newly catering for the requirements of service roads where necessary. Additional land required for future loop lines in all stations shall be proposed in the beginning stage itself.
- Embankments shall have a top width of 6.85m with the side slope of 2:1, cuttings shall have a width of 6.25 meters, excluding side drains on either side with a side slope of cutting 1:1 or steeper depending upon the nature of strata. Where bad soil is encountered, such locations shall be identified for a detailed investigation later.
- Bridges are proposed for single line and shall be designed for modified B.G loading and water way required is to be provided as per Indian Railway codal provisions.
- ROB/RUB is proposed across all national highways and state highways. For all other road crossings level crossings of appropriate class have been proposed.
- Alignment of existing LT/HT power lines and P&T communication overhead lines and cables should be ascertained to estimate the feasibility and cost of crossings, risings and diversion as also extension of power supply, distribution lines to propose state sites, level crossings and other installations.
- The permanent way will be 52 kg class – 1 rail on PSC sleepers of M+ 7 densities with a ballast cushion of 250 mm of hard stone ballast.
- The mode of traction is Diesel. Vertical clearance as well as horizontal clearance for all the structures shall how cater for electrification (25 KW AC)
- All stations are provided with basic traffic facilities and passenger amenities as required for the particular class of station. Platforms at crossing stations have been proposed to accommodate 26 bogies. Platforms at halt stations have been proposed to accommodate 18 bogies with provision for future extensions to 26.
- The signaling and interlocking shall be standard 3 with MACL signals with centralized panels interlocking arrangements.The gauge of the proposed line between Nagappatinam( take off from Papakoil, which is newly proposed on the new B.G line between Nagappatinam and Vailankanni) and Thiruthuraipoondi via Thirukkuvalai is broad gauge (1676mm).
- The mean sea level is the datum to which levels are referred.

At this stage the constraints of the projects are identified and suitable remedial measures are suggested to complete the project in time by adopting all standards of railway to save the national economy.

**IMPORTANCE OF THIS STUDY**

After a detailed study on this project all Land acquisition works were completed by the railway officials with the help of revenue officers. According to the soil tests at a depth of 1.5m depth the maximum N value at site is 9 and maximum safe bearing Capacity is 9 T / sq m. Existing soil at this terrain is clay and black cotton soil. Soil found with poor bearing capacity. Based on the soil report the sub soil has to be strengthened before execution.

**LITERATURE REVIEW**

**You-chang Hu (2009) et.al state** that in order to investigate the behavior of geosynthetic-reinforced soil (GRS), a series of laboratory experiments were conducted on GRS samples made up of granular soil and a nonwoven geotextile.

**Binod Shrestha and HadiKhabbaz (2010)** state that reinforced soils have been widely used in different variety and range of applications. Applying vertical reinforcement along with conventional horizontal reinforcement, a new concept of soil reinforcement, is proposed in their study. This study also presents possible methods of construction process. This technology can add numerous benefits to the current industry of soil reinforcement."

**B.S. Asha (2012) et.al state** that the developing countries like India are facing challenging infrastructure projects on fine grained compressible soft foundation soils in the areas of airways, highways and railways. Therefore an attempt has been focused in this paper to provide new techniques for ground improvement using Natural Prefabricated Vertical Drains (NPVD) and Polymer Prefabricated Vertical Drains (PPVD), geocell and geofoam."

**As per Guidelines and Specifications for Design of Formation for Heavy Axle Load**

**Research Designs & Standards Organization /Lucknow – 226011** states that the Vertical drains are used where preloading alone shall not be efficient. Vertical drains in soft clay accelerate the primary consolidation of clay since they bring about rapid dissipation of excess pore water pressure. Vertical drains have no direct effect on the rate of secondary compression but the early completion of primary consolidation brings about the earlier onset of secondary settlement. Therefore the structures or embankments can be put to use

Volume : 4 | Issue : 4 | Special Apr Issue 2014 | ISSN - 2249-555X

earlier than it would be possible otherwise.. Vertical drains can be successful in accelerating the rate of consolidation of soft fine-grained soils. They are, however, ineffective in organic soils and highly stratified soils. Generally the drains are installed by any of these methods depending upon the site conditions and availability of equipment. "

**PRE- FABRICATED VERTICAL DRAINS**

Prefabricated vertical PVC drain can be defined as any prefabricated material or product consisting of a synthetic filter jacket surrounding a plastic core. Because of their shape, they are also known as band or wick drains. They are manufactured in rolls of 200 – 300 m and are interested into ground to required depths using special drain stitcher rigs. Generally, installation takes place upto full depth of compressible soils. PVDs have replaced conventional sand drains for soil Consolidation due to their speedy and easy installation and unlike sand drains, they act as an integral unit during the process of consolidation.

**Site view showing the installation of PVDs**

**IMPORTANT ACTIVITIES INVOLVED**

1. Removal of top soft soil/ organic clay up to 1.00m or as required. If firm ground of sand or silt is available for 1.0 m depth, the same need not be disturbed.
2. Provision of well compacted course to medium grained sand for a depth of 30 t0 50 cm to act as filter media above the prepared ground surface.
3. Provision of prefabricated vertical sand drains (PVSD) at an interval of 1.5 to 3m in triangular or square grid fashion for a depth of 8 to 12 m from ground level. Normally drains should extent to the depth of the poor soil or two times the height of the embankment. PVSD shall be appropriate specifications as specified.
4. Execution of earthwork above the sand layer upto formation level with extra 1m preloading with earth.
5. The overburden soil will increase the pore water pressure in the clay and the water will escape through the PVSD drain through capillary action and by the soil overburden. Once the water available between clay particles escape the reorientation of the particles will density the clay layer.
6. Removal of extra earth after six months or after attaining the complete consolidation. Consolidation should be checked with settlement gauges and compared with theoretical settlement obtained through studies including tri-axial test and settlement calculations.

**Preparatory arrangements at site**

1. Base area of the embankment is divided in to field of size 30x50m or so by providing barriers if required to pump out water.
2. Water, if percolates, should be pumped out fully leaving the creed bed to dry. Coffer dams if required should be provided.
3. After drying, the slush/ organic material is removed up to 1.00 m by using machinery as required.
4. Sand should be filled then in layer up to a depth of 30-50 cm and compacted with a vibratory roller of 1-2 ton capacity.
5. The prefabricated vertical drains can be installed by using appropriate machinery

**Advantages**

- There is no risk of PVD during installation while sand drains can have discontinues if the mandrel is withdrawn too fast.
- There is no risk of shear failure of PVD s during settlement as compared to sand drains.
- PVDs are a consistent factory produced product wherever sand drains are subjected to quality variance.
- The rate of gain of strength is rapid and significant.
- The method is more reliable and faster.
- Economy – The main idea behind the Vertical drain technology, which is the maximum possible use of the soil bearing capacity, makes this technology one of the most economical technologies of the soil improvement.
- Environmentally friendly – While installation of drains no concrete or cement injections are used
- Organically checked – The simplicity of implementation makes the technology efficient for the use in organic soil with high moisture content which has been thoroughly tested in various applications.
- Predictable- Long experience and through soil testing allow for precise estimation of settlement rate and consolidation time.

**CONCLUSION**

The ground improvement techniques, including PVDs, can be applied prior to rail track construction in coastal areas containing soft soils. Relatively short prefabricated vertical drains can be used under rail tracks to improve track stability by dissipating excess pore pressure and to curtail lateral displacement within the critical Shallow depth beneath the tracks.

Volume : 4 | Issue : 4 | Special Apr Issue 2014 | ISSN - 2249-555X

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