7th National Conference on
"Role of Engineers in Nation Building" organized by VIVA Institute of Technology, Mumbai
(1st and 2nd March 2019)
International Journal of Engineering Research & Science (IJOER)
ISBN: [978-93-5321-411-1] ISSN: [2395-6992] [Vol-5, Issue-3, March- 2019]

# Study of Ground Improvement Technique

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***Abstract***—*It is due to rapid growth of population, fast urbanization and more development of infrastructures like buildings, highways , railways and other structures in recent past years has resulted in reduction of availability of good quality of land. Therefore engineers have no choice left except to use soft and weak soils around by improving their strength by means of suitable modern ground improvement techniques for construction activities. At present the available ground improvement techniques are replacement of soil, vertical drains, stone columns, Vibro compaction, dynamic compaction, soil reinforcement, Vibro piers, in-situ densification, pre-loadings, grouting and stabilization using admixtures. The aim of these techniques are to increase the bearing capacity of soil and reduce the settlement.*

***Keywords—ground improvement, vibro piers, grouting, admixtures, vibro compaction.***

## I. INTRODUCTION

The social, economic, cultural and industrial growth of any country depends heavily on its transportation system. The only mode which could give maximum service to one and all is transportation by highways and railways. As a result of development of infrastructures like buildings, highways, rail-ways and other structures in recent past years has resulted in scarcity of good quality of land for construction projects. Therefore the engineers are bound to adopt inferior and weak soil for construction. In present scenario the role of ground improvement techniques has become an important and crucial task for various construction projects. By ground improvement techniques the strength of the soil increases, its compressibility reduces and the performance under applied loading enhances. The expansive and collapsible soils are challenges to engineers due to their peculiar behavior of high swelling and shrinkage action.

The construction of foundation on sanitary landfills, soft soils, organic soils and karst deposits are troublesome. It is to better to replace or bypass such type of soil strata by adopting suitable design of foundation and if not possible the ground improvement is the best solution for a such construction project site.

The availability of land for the development of commercial, housing, industrial and transportation, infrastructure etc. are scarce particularly in urban areas. Many of these areas are covered with thick soft marine clay deposit, with very low shear strength and high compressibility. Many methods for ground modification and improvement are available around the world now, including dewatering, compaction, preloading with and without vertical drains, grouting, deep mixing, deep densification and soil reinforcement are among those. These methods have become practical and economical alternatives for many ground improvement applications. Ground improvement techniques basically utilize the effects of increasing adhesion between soil particles, densification and reinforcement to attain one or more of the factors such as increased strength to improve stability, Reduced deformation due to distortion or compressibility of the soil mass, Reduced susceptibility to liquefaction, and Reduced natural variability of soils.

This paper presents thorough study on various available modern ground improvement techniques and their applications in civil engineering in present scenario.

## II. OBJECTIVE

Ground improvement techniques are used increasingly for new projects to allow utilization of site with poor subsurface conditions. Previously, these poor soils where considered as economically unjustifiable or technically not feasible and are often replaced with an engineered fill or location of the project is changed. In short, ground improvement is executed to increase the bearing capacity, reduce the magnitude of settlements and the time.

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Few effective objectives are,

- Reduce distortion under stress.
- Reduce compressibility (volume decreases due to a reduction in air voids or water content under loads).
- Prevent detrimental physical or chemical changes due to environmental conditions (freezing/thawing, wetting/ drying).
- Reduce susceptibility to liquifaction.
- Increase bearing capacity/strength.
- Reduce natural variability of borrow materials and foundation soils

## III. LITERATURE REVIEW

### 3.1 Nijole Bastieneet.al,2003

studied that "An Assessment of Lime Filter Drainage Systems" The infiltration of water into these soils is too slow therefore frequent surface ponding occurs. It follows that clay soils are usually poorly drained and difficult to manage when wet. Agricultural activities and mechanisation are extremely restricted without adequate drainage (Ritzema, 1994)[13]. Besides, clay soils often have a seasonal variation in hydraulic conductivity because of swelling and shrinking (Tuller & Or, 2003). Due to the swelling of clay, rainfall is unable to percolate deeper into drains. It either accumulates in depressions or discharges as surface runoff. Therefore the effectiveness of subsurface drainage of clay soils much depends on the permeability of trench backfill. Based on the assumption that 2.5% of the soil volume in a newly tile-drained clay soil is made up of backfill (0.5 m wide pipe trench and 20 m drain spacing), it is obvious that the backfilling method has a great impact on drainage efficiency of such soil (Ulén, 2007)[13]. Traditional subsurface drainage in such soils does not always ensure excess water removal within the normative period; therefore, adding of the amendments to the trench backfill increasing water infiltration rate is practiced frequently. The permeability of these soils can be greatly improved by filling the trenches with coarse material. In Western Europe gravel was used for drainage trench backfill (Ritzema, 1994; Smedema et al., 2004)[13]. However, in some countries this is too expensive because of the limit of natural resources of gravel.

### 3.2 J.Parkinson et.al,2007

studied on "Rapid urban growth in developing countries" has resulted in the proliferation of informal settlements. These are opportunistic developments taking advantage of unused land, both privately and publicly owned. In some cases, the land may be earmarked for future development whereas in others it is assumed to be inappropriate for construction owing to physical or environmental factors. The housing within informal settlements is virtually always built without the consent of the official planning authorities and rarely conforms to official planning guidelines, building regulations and construction standards.

### 3.3 Erik Ristenpart, 1999

studied on he showed that "the development of large city planning projects without considerable disturbances of the local water cycle is feasible". Optimum solutions have to be found by an integrative plan- ning approach involving city-, drainage-traffic- and green-planners. Best management practices for general planning of storm drainage are applicable even in large development areas with restrictive water authority regulations. Innovative source control measures are working well even in low permeable soils when thorough planning leads to good adaptation to local boundary conditions. For the planning work, a sophisticated modelling tool is required which is applicable to both alternative and conventional stormwater management system.

### 3.4 Anand J Puppala, Aravind Pedarla, Tejo Bheemasetti (2004),"

Soil Modification by Admixtures – Concepts and Field Applications." Problematic soils are those that are weak in strength and will undergo large volume change deformations due to moisture content changes from seasonal fluctuations. Soft soils experience large settlements when they are loaded and these naturally result in excessive settlements of the structures built over them. In some scenarios, swell and shrinkage distinctiveness of expansive soil can cause significantdamage to structures. The magnitude

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or extent of swell – shrink movements depend on the clayey soil type and environmental conditions including climatic conditions. Volumetric movements deteriorate thesubgrade material which, in due course, leads to the development ofcracksand permanent damages.Presently, U.S. alone spends Billions of dollars annually on the repair andmaintenance of afflicted buildings, roads and other structures built on problematic soils including soft and expansive soils(Nelson and Miller, 1992;Puppala et al., 1997; 2007; 2013).

### 3.5 Seah, Tian, Kim, Tae Bum and Nguyen, Thanh Dat (2005),"

Ground Improvement via Vacuum Consolidation Method in Vietnam."The vacuum consolidation method (VCM) was first introduced to some Southeast Asian countries, including Thailand and Malaysia, back in early 2000s. The largest vacuum consolidation application in Southeast Asia during that period was carried out at the Bangkok Suvarnabhumi International Airport (Seah, 2006) with a total treatment area of over 240,000 m2. The success of the vacuum application in Thailand had led to the introduction of this method in Southern Vietnam with similar soft ground conditions. For past few years, the VCM has become one of the most popular ground improvement methods in Vietnam with project scale far greater than other countries second only to China. The main advantage of the VCM method is that it accelerates the consolidation of the soils with installed vertical drains in a relatively stable manner. In conventional PVD method, stage loading is required to control the stability through strength gain via consolidation, but the vacuum consolidation method increases the effective stress with very small change in the shear stress, creating a gain in effective stress with better stability. Typically, a minimum of 6 ton/m2 or 60 kPa of vacuum can be achieved in the depressurized improved zone with installed vertical drains as illustrated in Figure 1, and this vacuum pressure is equivalent to the load of around 3 m of surcharge fill. The effectiveness of the method depends greatly on the sealing or isolation of vacuum within the depressurized zone and the distribution of vacuum in the drains. Therefore, the PVDs used have to be designed to withstand the vacuum pressure; any collapse of flow channel within the drains will result in catastrophic consequences, such as embankment failure or unacceptable degree of consolidation. As a result, this type of work is normally executed by ground improvement specialists. Each specialist firm will adopt his own vacuum application system ranging from the type of drains to connections and vacuum pumps etc.

## IV. METHODOLOGY

For proceeding of further work we had selected a field in Mira road west which is a marshy land having wet soil. We will carry a important survey for collection of data and inspection of field, we'll collect survey reports from nearby construction companies who had constructed projects nearby that land. We will collect different soil sample from fields to analyze and conduct tests in laboratory so that we can conclude important analysis for land. After conducting tests we will collect all actual reading and compare it with theoretical data by different formula.

Vibro-replacement with stone columns allows for the treatment of a wide range of soils, ranging from soft clays to loose sands by forming reinforcing elements of low compressibility and high shear strength. In addition to improving strength and deformation properties, stone columns densify in situ soil, rapidly drain the generated excess pore water pressures, accelerate consolidation and minimise post-construction

settlement. In this paper, the design methodology, installation methodology, load testing and field instrumentation for vibro replacement with stone columns for railway embankments have been discussed. The results from numerous load tests and settlement plates indicate that the stringent performance requirements of the new railway project were met. Ground improvement by means of dry deep soil mixing allows for the treatment of a wide range of soils, ranging from soft clays to loose sands by forming stronger reinforcing elements of low compressibility and high shear strength. In this paper, the design methodology, installation methodology, load testing and field instrumentation for dry deep soil mixing for railway embankments have been discussed. Results from numerous load tests, settlement plates and inclinometers indicate that the stringent performance requirements of the new railway project were met.

Piled embankments were designed for use for the bridge approach transitions and allow for the embankments to be constructed rapidly without any slowdown in the construction rate or sequence. Piled embankments also eliminate the effect of settlement and stability problems.

## V. CONCLUSION

From the study it can be concluded that the Ground Improvement Techniques is a technically viable and cost effective solution for soils which are weak in strength and treatment is to be done in order to make them suitable for construction. The use of various techniques have been tested and its use has been proven in the recent past years for a variety of projects like highways, ports, runways, industrial structures, railways, dams, slope stabilization, excavations, tunneling and other infrastructure facilities. These methods of soil stabilization have been used world-wide for variety of soils like loose sand, silts, clays and weak rocks. A suitable and cost effective technique for ground improvement can be designed, keeping in view the following points:

- Nature and type of soil
- Intensity of loading and
- Intended performance

In addition to above, before selecting any ground improvement technique it is important to evaluate the cost of each particular method and expected soil improvement, available equipments, which are the decisive factors for the selection of appropriate method. There are so many methods available for ground improvement but still a method which suits for routine application, perhaps not available.

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