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Innovative Techniques in Ground Improvement

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ABSTRACT

Need for effective ground improvement has been attracting the attention of field consultant and research scholar all over the world for quite some time. For obvious regions ground improvement is becoming necessary as a large variety of soil conditions exist where ever a sensitive and major construction is planned. Better areas have been utilized and the growth of urban centers has become dependent on building, structures in the peripheral areas, presently under different land uses like supporting surface bodies, belonging to bad land conditions or agricultural lands. It has been found that lands reclaimed from water logged areas and from water bodies possess dead or passive soil layers up to a few meters from top, composed of detrimental material, slush and humus rendering the top soil as totally useless for founding any structure upon. Such areas also support raised water table profiles which further reduces the strength of almost dead and passive soil.

Such areas which are invariably present in the out skirts of every growing urban center in countries like India. The field engineer, developers, builders and authorities all face the problem of building economical and safer structures or habitation, particularly with the present trends of high rise structures.

The problem becomes double edged as a heavy structure has to be placed on the weakest soil, leaving only one option of improving the behavior of such soil materials in order to make it suitable for the planned structure, lots of methods and techniques have since been developed for ground improvement, as already said that no two conditions are similar therefore same techniques or method may not necessarily be effective in both the cases. Innovative methods and techniques therefore have to be created, experimented and monitored.

INTRODUCTION:

The high population density in India has led to the expansion of urban areas incorporating new building construction and associated infrastructure. The large number of studies has been done in this area as, C. J. Serridge (2006) work shows that the novel application of vibro stone column (vsc) and vibro concrete column (vcc) techniques beneath new highway embankment construction over soft ground and the steps required to permit successful ground improvement implementation. This draws upon recent experiences on the M60 orbital motorway widening around south Manchester and a new relief link road construction in Kings Lynn, Norfolk (UK) [1].

Alireza Afkhami (2009) presents the case study of ground improvement using Impact Pier soil reinforcement at the Chilliwack General Hospital in southwest British Columbia, Canada. The subject structure is a post-disaster 2-storey emergency room addition to the existing hospital. Subsurface stratigraphy consists of a "firm to stiff" silty clay to clayey silt which extends to 1.5 to 3 metres below ground surface, overlying a "very loose to compact" silty sand/ sand that extends to 4.3 to 5.2 metres. Below this depth a "compact to very dense" sandy gravel to gravelly sand was encountered. The ground water level was observed at 2.7 to 3 metres below ground surface. The loose to compact silty sand was found to be potentially liquefiable. The subject Impact Pier soil reinforcement method was utilized to improve the properties of the liquefiable layer at the subject site[2].

A large tract of land around Jabalpur has thick soil cover consisting of sandy silty and gravely soil with raised water table conditions the result is that the bearing capacity determination in such lands is problematic and taking decision regarding the foundation level or the type of foundation to be preferred under such condition becomes very difficult.

Geophysical instrumentation is a vital arm of the sub surface exploration and is recognized as such, by every field investigator. The methodologies are provided in Section II of the Part VI of NBC 2005. Geo physical instrumentations are done for determining the ground characteristics up to any depth and over any size of the terrain[7, 8].

As the demand for more and more land area is increasing, for the expansion of the urban towns the possibility of worse and weak land areas being made available for bigger civil engineering projects also increases; which calls for upgrading the ground conditions or better ground improvement in order to improve the project worthiness of the area. Various methods and techniques for ground improvement are adopted and in the field of the Geotechnical engineering. This aspect is viewed as advancement.

Present paper endeavors to suggest some novel techniques of ground improvement which have been found suitable for conditions existing in Jabalpur area of Madhya Pradesh[7,8].

METHODOLOGY:

A particular instrumentation is designed to yield specific information for specific objectives. Most commonly used methods are Gravity Instrumentation, Magnetic Instrumentation, Seismic Instrumentation, Electrical Instrumentation, Radio Active Instrumentation.

All these constitute parts of remote sensing done below the ground surface. All these instrumentation methods belong to the category of in-situ field exploration methods also known as non- destructive test method and are also known as non invasive testing methods. The advantage of these methods is that they are versatile, economical, precise, easily transportable, and require much less time and manpower to conduct sub surface investigations for a large area. The versatility of such instrumentation is that they can be used in any type of terrain conditions where accessibility of normal field test equipments, personnel and implementation is either difficult or impossible. The only requirement for such high precision instrumentation is that they require very high degree of experience and understanding for correct interpretation of the results of these instrumentations. Ground improvement in any particular area would require a proper assessment of the defects of the ground, qualitatively and quantatively prior to deciding the type, methodology and extent of ground improvement. This assessment needs a dependable method of investigation of the ground up to the required depth and for deciphering of the sub surface defects present in the ground. Electrical methods of geo-physical instrumentation are much in vogue in the western countries and are also being practiced now in India by experienced and knowledgeable workers in the field. The methods, which is known by different names 'vertical

electrical sounding' (VES), 'Vertical Electrical Coring' (VEC), Electrical Penetration Test (EPT) or as Geo electrical sounding (GES).

Various names given to this method represent various configurations of electrodes for different objectives for which the instrumentation is being conducted. The data obtained from this non-invasive testing method is capable of yielding a treasure of information from below the ground such as

1. Soil stratification and thickness of the overburden
2. Soil bed rock contact profile.
3. Water table position and profile.
4. Density of the materials present in various layers along with their moisture content and so on.

Assessment of ground improvement required for the structures, the type of foundation, and the depth of foundation, is determined by the characteristics of the material lying below the ground level. If the material is weak, if the water table is shallow, if the area represents a reclaimed or back fill area or has any other structural defect like buried channel faults, sink holes, cavity, etc. it can be found out from careful electrical instrumentation and corrective measures for ground improvement can than be decided from the sub surface data. The type of ground improvement and the methodology can then exactly decided.

It is also possible to monitor the improvement caused by the ground improvement methods and techniques using the same instrumentation method.

Simple option available could be providing -

- Vertical sand drains connected to horizontal drains for speedy dewatering of the land.
- Cutting of entry of ground water into the area from the direction of movement of ground water.
- Replacement of top sandy / silty soil by a layer of well sorted boulders laid in layers manually in order to improve the bearing capacity, create high permeability zone for lateral movement of ground improvement and for eliminating pore pressure conditions and also possibility of liquefaction of soil during earth quake conditions.
- A Raft foundation can suitably placed on this improvised stone layer after designing for the proposed structure.

OBSERVATION AND RESULTS:

Electrical resistivity method has been used for three to four high rise structures built on reclaimed water logged areas in Jabalpur successfully. EPT data of the area upto a depth of 10.0 m below GL, along with SBC values computed on the basis of EPT data as shown in the table 1.

Table 1: EPT data of the area upto a depth of 10.0 m below GL

S.No.	Depth in mts	SBC Vale in T/m^2
1.	1.0	NA
2.	2.0	NA
3.	3.0	0
4.	4.0	5.0
5.	5.0	8.0
6.	6.0	12.0
7.	7.0	18.0
8.	8.0	22.0
9.	9.0	25.0
10.	10.0	35.0

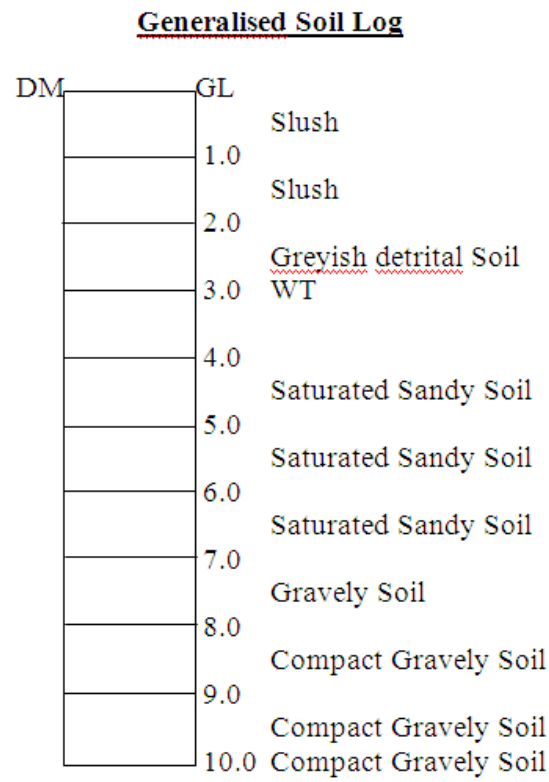


Fig1. General Soil log

For such conditions, Soil material above W.T. is scrapped and replaced by stone layering (Boulders - 25-30 cm size) 50 cms thick manually stacked as shown in fig. 1. This has been tested for improved ground conditions and SBC values at 4.0 M depth as 25-30 t/m^2 instead of the originally obtained value of 5.0 t/m^2.

CONCLUSIONS:

Electrical resistivity is a non destructive go physical method possess a very high potential to explore the sub surface by using the electric resistivity data. The log prepared using electric resistivity techniques are very simillary to the logs obtained from actual drilling methods. The ground improvement technique adopted for the stabilization of marshy land having very low bearing capacity was replacement of weak soil above the GWT by a thick layer of stone boulders, was found successful to elevate the safe bearing capacity up to the desired level.

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