Risk Assessment Of Constructing High Rise Buildings In Lateritic Soil For Selected Zones Of Udupi District

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Abstract: The current study done is based on the geotechnical and micro structural analysis of lateritic soil samples collected from eight different places in and around Udupi district located in Karnataka state, India. The main aim of the study is to understand the strength characteristics of lateritic soil for the purpose of construction. Microstructure of soil is very important for studying both mechanical and physical properties of soil. An effort was made to identify and to form a link between geotechnical and microstructure behaviour of lateritic soil. Geotechnical tests include natural water content, specific gravity test, sieve analysis, Atterberg limit, standard compaction tests, unconfined compression test (UCC). To evaluate the micro structural uniqueness which follows mineral composition, distribution of minerals and oxides present, Scanning Electron Microscopy and Energy Dispersive X-ray spectroscopy were carried out. On the other hand, effective Risk Management is also an important task to be taken care, hence the formation of risk matrix is done and the ranges of risks are decided using a five point Likert scale. As the safe bearing capacity of soil (SBC) plays a vital role in construction phase, the risk matrix is formed by considering the SBC of soil.

Index Terms: Cost matrix, Geotechnical Tests, Risk Matrix, SBC risk.

1. INTRODUCTION

Lateritic soil is one of the types of soil, which is abundantly seen in coastal regions of Karnataka state. Soil being a complex mixture of minerals, air and few organic matters, it becomes a major factor to study in detail about the nature of soil before carrying out any sort of work on it. The present study advocates, the study of lateritic soil in the selected zones of coastal Karnataka with respect to the mineralogical properties and consequent geotechnical properties soil, thus to understand the strength variations in the mapped zones and to characterize the zones which pose risk in construction of dwelling buildings. Risk Assessment is the first stage of risk management. Presently, a huge number of risk management approaches are present, but none of them relate to a condition where numerous factors are required to work on one plan. The first mission is to categorize the risk that happens by shaping the work in gradually multifaceted project systems. Risk Management's intend is to make out the opportunities and alleviation strategies to diminish possibility and happening of an event.

The aim of the study is to know the impact of this lateritic soil property on the foundation cost of residence buildings and to conduct a risk in sequence Model, which will denote the Risk occupied in the construction in the places enclosed in the Zonal Map, as designers and contractors should realize the relationship with varying foundation soils and the infrastructures. Construction has three phases for its proceedings. It includes Pre-Building Phase, Building Phase and Post-Building Phase. Understanding an ecological effect on structure in the pre-building phase can successfully lead to the wise selection of construction materials. The name laterite soil arrived from Latin word 'Later', which means Brick. Their origin includes a large sequence of processes starting from the transformation of various early rocks such as olivine, magnetite, limonite, feldspar, quartz and clay minerals [11]. Laterite are a typical source of foundation complications of buildings, roadways, dams and railway lines in west coast of India as it is main underlying soil. In India, lateritic soil is all over covered in the coastal region of area is founded. Lateritic gravelly soil or Lateritic soil is one of the types of soil that is abundantly seen in coastal regions of Karnataka state. The economic predominance of lateritic is a used as the different source in the construction history, so it has been made the topic for research field [12]. Soil is the most important material, which is in used for construction of civil engineering buildings. In respect with the foundation of structures, the capacity of building should be containing the load equally. As depth of foundation increases ultimate bearing capacity of soil increases. With other factors unchanged the type of failure of soil, depth of foundation, and effect of water table also governs the bearing capacity of soil [9]. Thus, we can say that foundations are the structures, which take the entire load coming from structures and transfer them to underlying soil by doing that it supports the structures capably. The general practice of doing color and appearance as needed point of reference in understanding suitability for setting up needs to be review in content of the inconsistency in the inorganic, synthetic and therefore geo-technic property of lateritic soils, which in selected [1]. Here two lateritic soils sandstone gneiss and amphibolites resulting were compressed at three unlike power and conducted to permeability tests. Outcome showed that the granite gneiss derived lateritic soil was suitable for using as fills for embankments and earth dams production when firmed at the force of the Standard test (0.60MNm/m^3). The amphibolites derived lateritic soil however had to be compacted at least 1.07 MNm/m^3 to be made acceptable for same purposes in content of its proportion less high dry densities and maximum compressibility [2]. As it suggests that bauxite is the one of the variety of laterite soils. It is having the some of the minerals like kaolinite; Gibbsite, Goethite, anatase and bohemite are the sampling, which are analyses here.

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Quartz and Micas are the minerals, which is not present in the samples. The soil consists of Laterite we can see through at the top with the covering. The soil consists of Laterite we can see through at the top with the covering. Porcelain clay minerals were initial build by the hydrolytic get through of aluminous sediments and then gibbsite was formed as early kaolin was desilicated. The laterite soils having the average percentage of about 50-58% of Al_2O_3 and 10-30% of Fe_2O_3. As the soil where collected from different places from the areas. All the location of about 2kg soils where collected and for each location, names were given of the soil-collected areas. The soils where tested with both Energy Dispersive X-ray Analysis (EDX) of different minerals are done through this and analysis for 38 number of the samples. Therefore, after analysis all the samples of the minerals like kaolinite, goethite, anatase, and gibbsite. From the study of the minerals, gibbsite is the high samples from the Analysis done. In the analysis Alumina is 40-58%, silica of 1-2%, Titanium of 5-16%. From the main study of gibbsite, it of 5-30%. Goethite is smaller than hematite in this bauxite. Only these type minerals not only found but metals like nickel, cobalt, platinum, gold, gallium, zircon, vanadium, etc. where create. These were formed under the good Atmosphere condition [3]. The regular practice of different types of surfaces used in the soil will make the construction in different form of variability in geochemical, compound and hence soil mechanics properties of lateritic soils and that places taken should be in limited boundary [1]. Here two lateritic soils, volcanic rocks derived and amphibolites derived, were compacted at all three points of dissimilar energy and permeability test were done. Results tell us that from the paper conclusion refer us that the lateritic soil as best for using for packing in bank of earth and earth dams of construction works when compressed at the energy of compaction test. (0.60MNm/m3). The amphibolites derived lateritic soil however had to be compacted at least 1.07 MNm/m3 to be made appropriate for same reason in examination of its somewhat low optimum dry densities and maximum compressibility [2]. It tells us about the unconfined compressive strength of soils in which it is the main process of soils. Test has been done of the soils of physical properties. However, the unconfined compressive strength has been one of the best, which has satisfied the condition. The soils have undergone the XRD of <2µm size soil fraction of samples. They also undergone SEM analysis of different layers as they took MP1, MP2, MP3. The height is considered up to 0.80-2.90 m. Soils contains from the mineralogical results aresmectite, muscovite, halloysite, quartzite, biotite and aluminum phosphate. After the EDAX analysis kaolinite as minerals which was main of it. And modified test was considering one the satisfied condition of the soils. Then for all the unconfined compressive strength they considering water content, dry unit with the proctor test where taken in this contents. If the material is to be used as hydraulic barrier, it must be compacted within water content of 13.9 and 18.1% and at a dry unit weight greater than or equal to 16.20 KN/m3 to possess the basic shear strength properties [8]. The main individual geotechnical characteristics of soils containing diatom and allophone have been seen and discussed. Here two soils containing to be very same, but they have different way of character tic is same that is surrounding genesis and other materials of the particles. Over broad pressures, the difference of tested values will be in the ranges of 39-43°, which is greater we accepted the values, which are unexpectedly high when, differentiate with sedimentary soils of similar density and PI. Here two types of method where taken in that, the first one is undisturbed specimens of diatom soils showed a path of pre consolidation of 800Kpa another method is remolded specimens is tested in lab at stresses of 3.2Mpa did not present any particular stress point that could be associated with significant particle crushing [15]. Higher the specific gravity, higher will be the load carrying weights of soil. Compaction improves the bearing capacity of soil and consolidation properties of soil indicate the settlement of the structures. Shear strength is the prime important factor for foundation design and mineralogy can have major role in the shear strength capacity of soil [14]. The experiment is done in gradation analysis in which it impacts on the strength property of moulds made from lateritic soils but not adding cements stabilization. Sample was collected from three different places; sieve analysis was done on the soil collected. Cubes were made and Compressive Strength was tested. The difference of this will have the Strength quality of the cube from the source of lateritic soil, its fineness was established [15]. This paper tells the importance of impact of size of footing on bearing capacity of soil with the relation between the depths of footing on bearing capacity soils. In which two methods can be done known as Terzaghi and IS code methods can be taken with different shapes like strip, square, circular and rectangle. However, if any changes occur in terms of footing the local shear failure is concern with the shape of footing with square, circular and rectangle footing [5]. Impact of shape of footing and impact of depth of footing on the bearing capacity of soil with the discussion on all about the parameters on which the bearing capacity mainly depends such as type of soil, depth of foundation, soil weight in shear zone and surcharge etc. The comparison for the values of bearing capacity by considering different shapes of foundations, the values of optimum moisture content, max dry density, cohesion, angle of internal friction and certain depth of foundations for the results obtained by Terzaghi equations and IS code values were done and it was found that sudden of changes in depth of foundation the properties of soil will be same, but as width of foundation increases the bearing capacity of soil increases [16]. This paper deals with investigations about the risks encountered in the South-Eastern United States. Six types of risks were identified are places with not in correct way of fill, sites with filled of unwanted of plastic soils, sites having rock, cavity in ground, shallow foundation construction and mechanically stabilized earth retaining wall design. Geotechnical risk in site will be having problems in all part of plan task which is having more multi task activities. (Ex: design, production and function) and is not restricted to the ranging of engineering properties. Brief detail is provided on each of the six types of risk, to tell how it can be resist in concern with the risk of the site [4]. The people need to be very careful of the work in the site. It is important that the construction management should be clear and understand properly of document works. When problems are reached high, the Engineer should have, capable of solving of it. He should be highly experienced in that condition and should be quick in solving the problems and give solutions for it [15]. A risk is the occurrence any event which can possibly harm the progress of a planned project which may effect on its completion as well. Assessment of risk is to find the probability of risk that can arise and to know the effect of such risk. Thus, we can call it as reasons and results analysis. Reason being

the cause of that event to happen whereas result may help in getting the possible impacts on the leading project [4]. A risk is the occurrence any event which can possibly harm the progress of a planned project which may effect on its completion as well. Assessment of risk is to find the probability of risk that can arise and to know the effect of such risk. Thus, we can call it as reasons and results analysis. Reason being the cause of that event to happen whereas result may help in getting the possible impact on the leading project [6]. Effective method of analyzing risk is by forming a risk matrix by considering risk factors and risk guidelines. A risk matrix is the one, which is used to rank risks or uncertainties. It involves the procedure of relating the probability of happening of risk and the effect of risks and put them together to designate the height of risk. An efficient Profile of risk can be created by this method. On the project, site risk factors can be anything including schedule, cost, labor or technical properties of soil etc. that can be analyzed by forming the profile zones having high, medium, low risk zones. Qualitatively, risk is proportionate to the probable harms that can be brought by some definite factors [19]. The Engineers work in the site should be known about the risks involved such as the characteristics of workers, changes in atmosphere and temperature, and the diversity of work types [18].

2 METHODOLOGY

The first step was the selection of strategic points or sites; this was done considering Haradi, Kumbashi, Hemmadi, Neralakatte, Vandse, Kota, Sasthana and Kandluru from those places the soil samples were collected. Undisturbed soil samples from the selected sites, which were available at an approximate depth of 2.5m from ground, were procured. From the collected soil samples, the geotechnical properties and safe bearing capacity (SBC) was determined using relevant tests.

2.1 Conduction of Geotechnical Tests

According to IS the test was conduct to establish the geotechnical property of the soil sample.

2.2 Core cutter method

The method is followed as per IS 2720 (Part XXIX) – 1975. This test is done to know the amount of compaction that the soil has undergone. To know the exact dry density of soil it is Important to have the both natural and compacted soil samples.

2.3 Specific Gravity

The specific gravity of soil sample was calculated based on the procedure mentioned in IS 2720 (Part III) – 1964. A weighed quantity of soil about 1000g in pycnometer bottle respectively. Weight of pycnometer bottle in empty condition, when filled with soil, filled with soil and water and only water is weighed separately. In addition, name them as W1, W2, W3, and W4. The specific gravity was calculated using the formula:
Specific gravity = G = (W2 – W1) / [(W2 – W1) – (W3 – W4)]

2.4 Consistency limits

Liquid limit

Liquid limit is the moistures content at which 25 blows in standard liquid limit apparatus will just close a groove of standardized dimensions cut in the samples by roving tool by a specified amount. Liquid limit of soil is determined using Casagrande apparatus as per IS 2720 (Part V) 1970.

Plastic limit

Take about 20gm of thoroughly mixed portion of the material passing through 425 microns I.S. Sieve obtained in accordance with I.S. 2720 (part 1). Mix it thoroughly with distilled water in the evaporating dish till the soil mass becomes plastic enough to be easily molded with fingers. Allow it to season for sufficient time (for 24 hrs.) to allow water to permeate throughout the soil mass. Take about 10gms of this plastic soil mass and roll it between fingers and glass plate with just sufficient pressure to roll the mass into a threaded of uniform diameter throughout its length. The rate of rolling shall be between 60 and 90 strokes per minute. Continue rolling until you get a threaded of 3 mm diameter. Plastic limit of soil is determined and using this plasticity index is calculated as per IS 2720 (Part V) – 1970.

Shrinkage Limit

Fill the dish in three layers by placing approximately 1/3 rd of the amount of wet soil with the help of spatula. Tap the dish gently on a firm base until the soil flows over the edges and no apparent air bubbles exist. Repeat this process for second and third layers also until the dish is completely filled with the wet soil. Strike off the excess soil and make the top of the dish smooth. Wipe off all the soil adhering to the outside of the dish. To determine the shrinkage limit of soils as per IS 2720(part IV)-1964

2.5 Grain Size Analysis

Grain size analysis for soil samples were done as per IS 2720 (Part IV) – 1965 to understand the particle size distribution. By plotting the graph based on the diameter of the particle in mm corresponding to 10%, 30% and 60% finer. The uniformity coefficient and coefficient of curvature are plotted on the graph, which clearly defines whether the soil is well graded over the range of coarse grained or fine-grained soil.

2.6 Compaction test

Compaction of soil is done as per IS 2720 (Part VII) – 1965.This is mainly done to know the amount of water to be added to achieve maximum density. Air-dried sample passing 20mm sieve is used for the test. For the mixture of soil prepared by adding certain specified percent of water the compaction is carried out using rammer by giving 25 uniformly distributed blows on each layer. The numbers of layers of soil place for standard compaction tests are three. Thus, the density values were obtained.

2.7 Unconfined compression test

The experiment is carried out mainly to calculate the unconfined compressive strength and un drained shear strength of a soil sample. The maximum stress can be obtained by plotting a curve of stress v/s strain. The test is carried out to find out the bearing capacity by considering the failure angle as per IS 2720 (Part XI) – 1971.safe bearing capacity values were achieved from the same test from table 1.

3 SOIL CLASSIFICATION BASED ON SBC

As the safe bearing, capacity of any soil is the extreme mean of contact pressure amongst the footing and the soil, which

should not create shear failure in the soil SBC, is considered as one of the major affecting factor for risk in subsoil and risk factors are calculated using SBC. Safe bearing capacity values were calculated using unconfined compression tests (UCC). The dial gauge readings were noted down as the load is applied on the allowed soil samples. Deformation of the specimens prepared is observed and the proving ring readings were noted down. By the obtained readings stress, strain and axial loads were calculated and with these readings along with the consideration of failure, angle suitable formulae were applied to get safe bearing capacity values of soil samples of the regions. SBC of each place are tabulated and based on the SBC, grading is done listing the soil profiles from very weak, weak, vulnerable, good and very good. The Average/Mean (M) and Standard Deviation (SD) of the SBC of all the places are calculated and the grading is done according to the below Table 1.

4 PREPARATION OF RISK MODEL & ZONAL MAPPING

Principle used to form the risk matrix is by the application of Likert scale, which is a tool used to understand the level of acceptability, Level of Support/Opposition, Level of appropriateness, Level of probability, Level of appropriateness, Level of agreement, priority, Level of probability, Level of agreement level of desirability, Level of participation etc. Likert scale is usually for either seven points scale or five points scale. Here for the simplicity of arrangement we are forming a five point Likert scales wherein the risk is classified as Low, High, Very High, Very Low, Normal, Very Low and Very Low. With the help of the formed matrix cost risk with respect to safe bearing capacity in all the opted places are analyzed. The key factors used for creating the risk matrix are three. And they are mean value of SBC, standard deviation and probability risk ratio. The mean and standard deviations are calculated and tabulated with certain notations used for cost risk and SBC risk which starts from one (very low) to five (very high) that is based on Likert scale. The assignment made is tabulated and shown in table 4. The SBC values are in KN/m^2.Choosing these colors to indicate a risk is purely based on assumptions. The risk is denoted according to the scale from green to red representing low risk to high risk. With the help of above formed table level of risk is drawn. The probability of risk is considered by multiplying SBC risk and cost risk and thus the peak of risk is calculated. Table 3 shows the margin of risk.

Table 1: *SBC Results*

PLACES	AVG SBC (KN/m^2)
HARADI	123.66
KUMBASHI	109.118
NERALAKATTE	279.562
HEMMADI	292.911
VANDSE	246.696
KOTA	229.813
SASTHANA	108.53
KANDLURU	209.846

Table 2: *Assignment of risk*

M+2SD	very high
M+SD	high
M	normal
M-SD	low
M-2SD	very low

Table 3 *Showing assignments done for cost risk and SBC risk*

			SBC RISK	COST RISK
M+2SD	352.299	VERY HIGH	1	1
M+SD	276.157	HIGH	2	2
M	203.451	MORMAL	3	3
M-SD	123.874	LOW	4	4
M-2SD	47.732	VERY LOW	5	5

Table 5 *Color denotation for risk*

VERY LOW	01-02
LOW	03
MEDIUM	04-09
HIGH	10-14
VERY HIGH	15-19
EXTREME	20-25

Table 4 *Assignment of risk from low to high*

	PLACE	DIMENSION	COST RISK	INCREASE IN COST (%)	RISK
1	HARADI	5m X 5m	10730.40	18.78	HIGH
		7.5m X 7.5m	19874.40	19.77	HIGH
		10m X 10m	32610.90	19.78	HIGH
2	KUMBASHI	5m X 5m	13482.38	23.60	HIGH
		7.5m X 7.5m	25002.0	24.87	VERY HIGH
		10m X 10m	39137.70	23.73	HIGH

Kumbashi comes under extreme risk zones and Kota and Kandluru comes under very high risk zone.

		Cost risk				
		1	2	3	4	5
SBC	5	MEDIUM - 05	HIGH - 10	VERY HIGH - 15	EXTREME - 20	EXTREME - 25
	4	MEDIUM - 04	MEDIUM - 08	HIGH - 12	VERY HIGH - 16	EXTREME - 20
	3	LOW - 03	MEDIUM - 06	MEDIUM - 09	HIGH - 12	VERY HIGH - 15
	2	VERY LOW - 02	MEDIUM - 04	MEDIUM - 06	MEDIUM - 08	HIGH - 10
	1	VERY LOW -01	VERY LOW - 02	LOW - 03	MEDIUM - 04	MEDIUM - 5

Table 6 *Increases in cost risk in terms of percentage*

- ❖ As per the calculations made, among eight places, four places i.e. Hemmadi, Neralakatte, Vandse, Kota and Kandluru there were no increase in the cost was observed. Thus, the places are risk free.
- ❖ Haradi, Kumbashi and Sasthana are found to be having certain increase in the total cost compared to the point of reference and according to the matrix formed. The percentage increase can be noticed in table 6.

5 RESULTS AND DISCUSSION

The soil samples were collected and allowed for different geotechnical tests. The main factor for soil being the safe bearing capacity, the risk matrix was formulated based on safe bearing capacity of soil samples. The strength for SBC varied from one place to other place and the variation in SBC values are 123.66,109.118,292.911,279.56,246.69,229.813,108.525 and 209.846(KN/m^2) obtained for the places Haradi, Kumbashi, Hemmadi, Neralakatte, Vandse, Kota, Sasthana and Kandluru respectively. The value of SBC obtained in region 2 that is Hemmadi seems to be highest compared to selected eight places and observed to be the lowest in Sasthana. The values are varied drastically as shown in Table 1. According to the risk matrix formed as per the consideration made for the risks, for the considered soil samples the cost risk is found to be extremely high in two places that is in Sasthana and Kumbashi and the risk is found to be coming under the category of very low again in three places i.e. in Haradi, Kota and Kandluru. The rest three places considered were found to be falling under medium risk zone, which includes Neralakatte and Vandse.

6 CONCLUSION

- As per the risk matrix formed, among the selected eight soil samples the three places i.e. Hemmadi, Neralakatte and Vandse were found to be coming under medium risk zones. Also Haradi, Sasthana and Hemmadi is the place with the soil sample having SBC of 292.911 KN/m^2, gives least SBC risk as well as least cost risk.
- Kumbashi and Sasthana were found to be having a SBC of below benchmark value, which in turns gives very high risk with respect to safe bearing capacity as well as cost risks.
- As per the calculations made the cost risk was found to be more in Haradi and Kumbashi with considerable increase in the cost of construction of foundation.

ACKNOWLEDGMENT

The authors wish to thank Department of Civil Engineering, Manipal Institite of Technology, Manipal Academy of Higher Education, Manipal for all the facilities provided.

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