

A Critical Evaluation on Geotechnical Characterization of Medical and Health Infrastructure Building Site at Mangalagiri, Guntur District, Andhra Pradesh, India

M.Madhusudhan Reddy, K. Rajasekhara Reddy

Abstract: The unique soil identification and evaluation is often regarded as one of the most important information for proper design of any civil engineering structures. Selection of Geotechnical investigation methods is depending upon site conditions and characteristics of soil vary site to site. Present study focused on physical characteristics of soils for a proposed medical and health infrastructure building site at Mangalagiri, Guntur district, Andhra Pradesh state, India. The investigation involves Dynamic Cone Penetration Test (DCPT) and Standard Penetration Test (SPT) followed by excavation with trial pits and trenches. Both disturbed and undisturbed soil samples were collected from twelve different locations of the study area at various depths from all the bore holes for studying physical properties of soils. Using the samples thus collected from boreholes, grain size distribution (GSD) charts were drawn to classify the soils and 2-D bore logs have been developed to understand the soil heterogeneity. The investigations revealed that the sub soil is comprising occurrence of predominantly red coloured medium dense sand with traces of laterite gravel up to a depth of 5 meters and dense sand and laterite gravel mixture beyond 5.0 m to explored depth throughout the study area.

Index Terms: Standard Penetration Test (SPT), Dynamic Cone Penetration Test (DCPT), soil samples, 2-D Bore logs, Mangalagiri.

I. INTRODUCTION

Due to the fast growing in population globally there is a huge demand for space utilization for commercial and economic development in infra-structure point of view to meet public demands. The sub-surface investigation is play vital role in selection of suitable foundation of any structure. The purpose of sub-surface exploration activity is to investigate the underlying ground features like type of soils, depth of hard strata, presence of water table etc. The investigation report facilitates to adopt proper foundation design and depth of foundation.⁴

Natural hazards like earthquakes, landslides, tsunamis etc., are become very common in human routine life due the hazards day by day failure of structures increasing. Site characterization by investigation is very important to prevent structure from failures and loss of human valuable life.²

Due to high rate of success in characterization of soil properties globally the use of Standard Penetration Test (SPT) and Dynamic Cone Penetration Test (DCPT) are become first choice. The exploration programme will give

adequate knowledge in sense I) Hydrological characterization such as ground water and likelihood of perched ground water II) Soil classification like Alluvium, colluvium, lacustrine deposit III) Depth and style of weathering IV) Stratigraphy of underlying layers V) Geological information such as joints, folds, faults.

II. RESEARCH SIGNIFICANT

The queen interest of the present work of sub-surface exploration is to provide the adequate knowledge in characteristics of soil like soil classification, presence of depth to water levels in the study area for proper foundation design and some other significant are mentioned below.

1. To obtain the sequence, thickness lateral extent of soil strata and appropriate level of bedrock.
2. To obtain representative soil sample for classification and identification of their physical parameters for proper construction design of foundation.
3. To determine the position of Ground Water levels (GWT).

Various methods are being adopted worldwide including India to explore the soils from different depths among all the methods sounding methods (SPT, DCPT) are mostly preferred due to easiest in operation and high accuracy in getting disturbed and undisturbed soil samples. The present investigation is restricted to only soils characterization with in the study area. Flowchart 01 shows methodology being adopted for present investigation to characterize the soils.

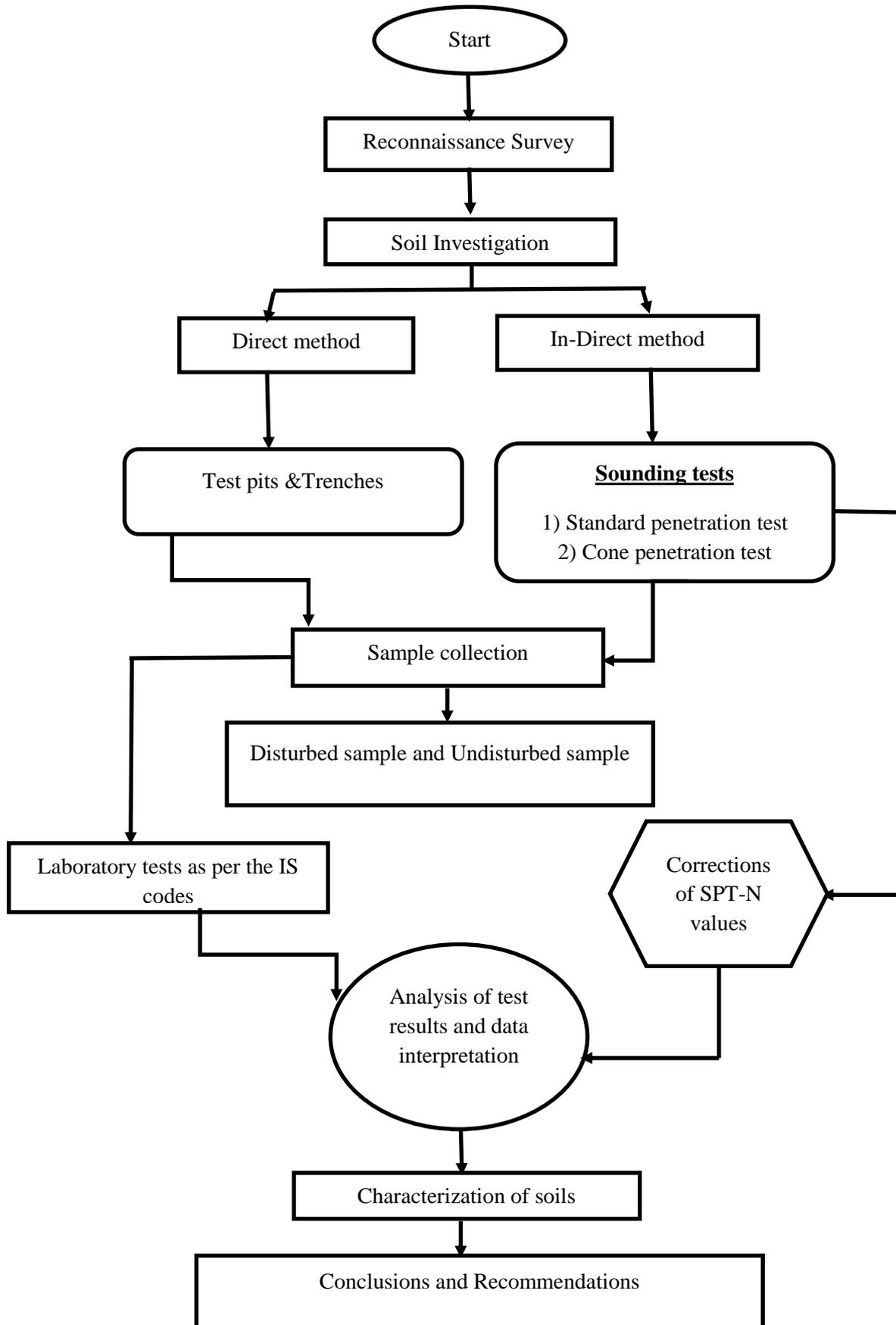
III. STUDY AREA DETAILS

Mangalagiri has become part of capital region development authority. Mangalagiri well known for cotton saris and important temples such as Narasimha Swamy and Panakala Swamy and pottery. The town is situated between Guntur and Vijayawada (Krishna) Districts along the national highway16. The proposed health infrastructure building site is suited 16°26'40.81" latitude and 80°34'50.15" longitude and it comes under Mangalagiri zone. Location map of study area is given in Figure 01.

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M.MadhuSudhan Reddy, Research scholar, Department of Civil Engineering, Koneru Lakshmaiah Education Foundation (Deemed to be University), Green fields, Vaddeswaram, A.P., India.

K. Rajasekhara Reddy, Associate Professor, Department of Civil Engineering, Koneru Lakshmaiah Education Foundation (Deemed to be University), Green fields, Vaddeswaram, A.P., India.



Flow chart 01: Methodology Adopted for present Investigation

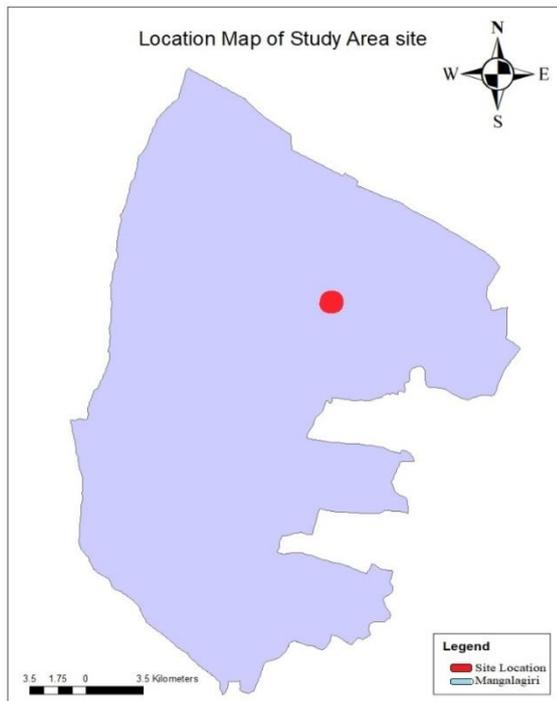


Figure 01: Location map of study area within the Mangalagiri town

IV. GEOTECHNICAL INVESTIGATIONS

The Geotechnical investigations reveal different properties of soil and depth to ground water table. The sub-surface exploration is carried out by using Trial Pits, SPT/DCPT in 12 different locations within the study area. Soil samples (Disturbed & Undisturbed) were collected along with consultancy agency at different levels during the exploration and tested in laboratory to understand the various engineering and index properties of soils. Various laboratory tests were conducted as per the recommended Indian standards.⁵

A. Materials and Methods

Accuracy rate in getting the sampling is depending on several factors, due to high success rate and simplicity in applicability of geophysical techniques in explorations. Many consultancy agencies preferring sounding tests in soil investigation namely Standard Penetration Test (SPT) to relatively hard soils and Dynamic Cone Penetration Test (DCPT) for soft soils.¹ Applying of correction to optioned SPT N value is a common practice in order to improve accuracy in penetration value due to existence of heterogeneity in soils.

B. Standard and Cone Penetration tests (SPT & DCPT)

SPT is most commonly used as in-situ test for soil exploration and majority of the structural designers consider penetration number for designing of foundation footing.³ In the present investigation Standard Penetration test is performed at 12 different location within the study area as per the code of practice. For sampling recovery, the standard split-spoon sampler is attached to a string of drill rod and same is lowered until to reach excavated ground surface and allowed to stay with only self-weight. For further advancing driving force is applied with the 63.5 kg hammer by

maintaining 75cm free fall on anvil till to reach maximum depth or up to a hard strata appearance. The number of hammer blows recorded to penetrate the initial depth of 15cm and then blows required for further 30cm depth penetrating is considered as standard penetration number N or SPT-N Value. Then the sampler was withdrawn from hole and soil extracted for subsequent test in the laboratory. Sampling locations in 3-D view are presents in Figure 02. From past few decades the cone penetration test is become more popular in geotechnical investigations and also in finding the characteristics of soil at different stratification. The most advantage in cone penetration test are its simplicity, accuracy and continuous measurements of CPT parameters like cone bearing (q_c) and sleeve friction (f_s).^{3,4} In the present investigation cone penetration test is performed in open pits up to a required depth with standard cone of outside diameter 50mm and with an apex angle of 60° is attached to a string drill rod by applying continuous hammer weighing of 63.5 Kg falling freely through a height of 75cm. The total number of blows required for the 30.0 cm penetration is considered as Cone Penetration resistance N_{cd} value.

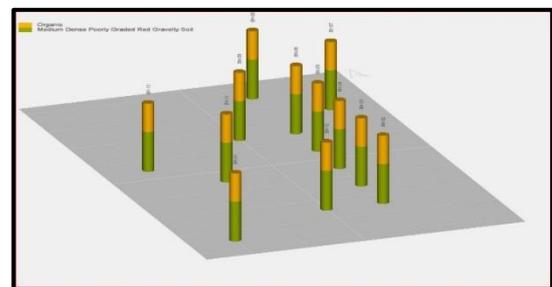


Figure 02: 3-D of borehole location points (not on scale)

C. Corrections of N-Value

Due to the repeatability and reliability in the testing process many problems are still associated in getting samples with the standard penetration test.³ Corrections have become necessary for standard penetration number (N) to choose proper design method for foundation. However, many researchers are worked and even working with correlations to achieve better reliability of SPT-N value for standardizing. In case of fine sands and silty sands below the water table generally develops pore-water pressure which leads to increase in SPT-N value. Terzaghi and Peck suggested the following corrections if observed penetration number exceeds 15.

1) Correction due to effect of overburden pressure,

$$N_R = N_C \times N \quad (01)$$

Where, $N_C = 0.77 \log_{10}(200/\sigma_0)$

2) Correction due to submerge effect (in case of fine sands and silt)

$$N_C = 15 + (N_R - 15)/2 \quad (02)$$

If $N_R > 15$, therefore $N_C = N_R$

where,



C_N = corrected SPT-N value,
 N_R = recorded SPT-N value.

Corrected SPT values are presented along with bore logs in Figure 03 And Graphs are drawn for observed SPT-N value and corrected SPT-N value and presented in Figure 05.

V. RESULTS & DISCUSSIONS

Observed SPT-N Values are ranging from 9 to 52. The corrected SPT-N Values are ranging from 08 to 33.3. In bore hole number 02 highest SPT-N value is observed and least values are observed in borehole numbers 1,2,6 and 7. The highest SPT-N corrected value is observed in bore number 9,10 and least value 06 is observed in majority of bore holes. The percentage of sand fraction is varying from 51.9 % to 81.6%. The grain size analysis of soils revealed the presence of higher percentage of sand in most of the soil profiles of bore holes. (Figures 04, 05, 06) Same tendency is observed in all the bore holes. Depth to ground water table is varying from 4.1m to 5.0m shown in Figure 07. From investigation it has been observed that the occurrence of predominantly red coloured medium dense sand with traces of laterite gravel up to a depth of 5 meters and beyond 5m up to explored depth dense sand and laterite gravel mixture.

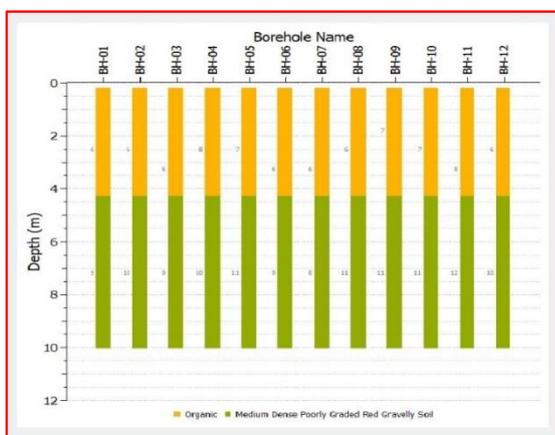


Figure 03: Bore logs with corrected SPT-N value at different depths

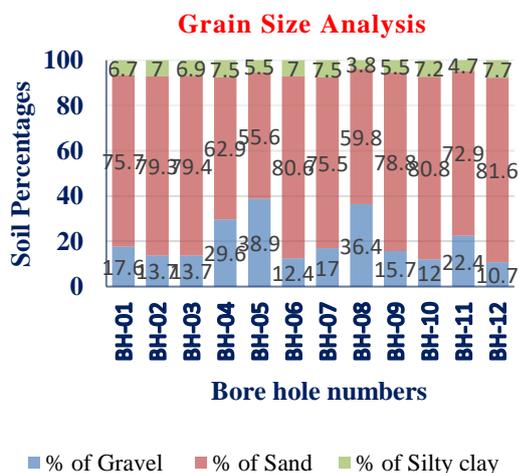


Figure 04: Grain size analysis of samples represented from different bore logs at a depth of 3m

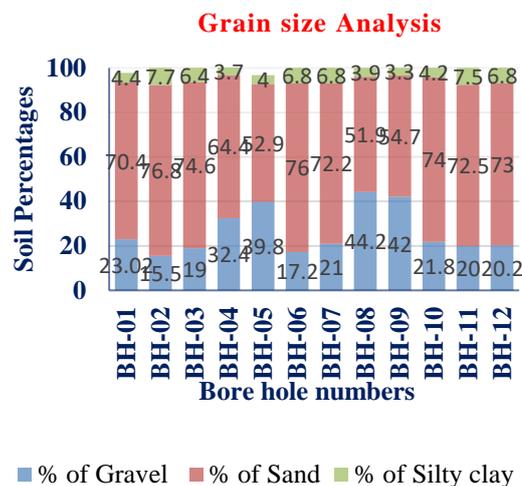


Figure 05: Grain size analysis of samples represented from different bore logs at a depth of 6m

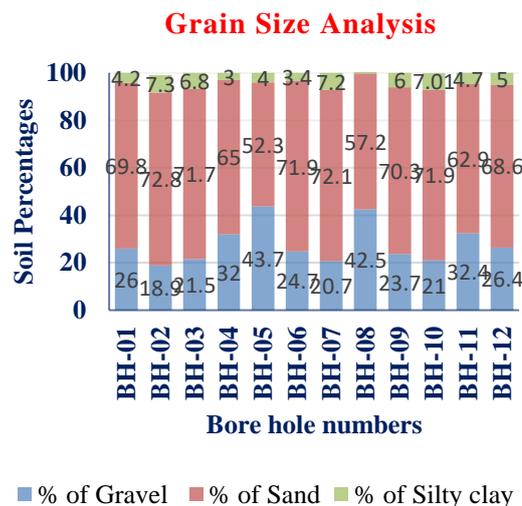


Figure 06: Grain size analysis of samples represented from different bore logs at a maximum depth

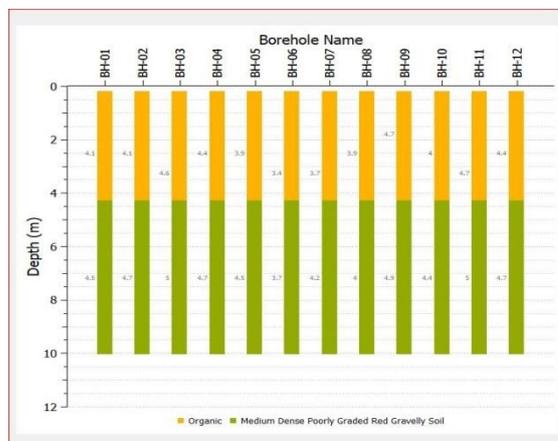


Figure 07: Bore logs with observed water table levels at different depths



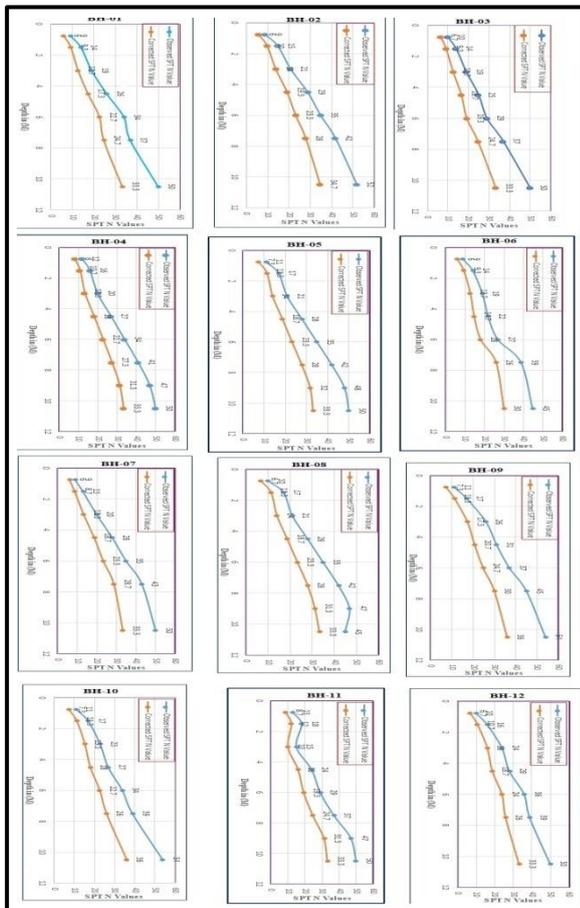


Figure 08: Graphs showing observed and corrected SPT-N values

VI. CONCLUSIONS AND RECOMMENDATIONS

From the above sub-surface investigations, the following conclusions are drawn and suggested recommendations.

- Red coloured medium dense sand with traces of laterite gravel soil is observed up to a depth of 5m and dense sand and laterite gravel mixture is encountered beyond 5m up to the explored depth. And in the entire bore holes sand fraction is higher.
- The area under investigation falls in seismic zone III as per IS 1893: 2002, hence it is strongly recommended the sub soil below foundation to be properly compacted before laying foundation. It is also recommended while designing the structure to go essentially for earthquake resistance design to withstand to seismicity.
- It also suggested backfilling of foundation soil to be compacted in order to achieve maximum proctor density.

In continues to this investigation it is suggested to carry out tests on safe bearing capacity and settlement analysis as there preferring to go for high rise structures in order to come up with suitable design.

VII. ACKNOWLEDGEMENT

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Authors Profile



Mr.M. Madhusudhan Reddy worked in Guru Nanak Institute of Technology for about a year (2015-2017). He received his Masters of Technology and Bachelor of Technology from JNTU Hyderabad. And went to KoneruLakshmaiah Education Foundation (Deemed to be University), Vijayawada for pursuing Ph.D. He is a life time member of Indian Geotechnical Society (IGS). Mr.M. Madhusudhan Reddy research interests are; I) Earthquake Engineering II) Soil-Structure Interaction III) Landslides & Slope stability IV) Ground Improvement.

Current Affiliations at K L University:

- Full time research scholar till date.



Dr. K. Rajasekhara Reddy received doctorate in Geology from Karnataka University, Dharward. He has put up 16 years of industrial experience in manufacturing of ceramic tiles in various areas of operation at different levels and 10 years of academic experience in Koneru Lakshmaiah Education Foundation (Deemed to university). His interests are exploring alternate low cost sustainable ceramic raw materials, developing economical ceramic tiles and sustainable irrigation systems. He has guided 10 M Tech students and guiding 8 Ph.D scholars