LOCATION MAP KASIDIH LAND PARCEL 1 & 2

LATITUDE : 22°46'51.66" N
LONGITUDE : 86° 9'55.88" E
PLOT LAYOUT WITH SPOT LEVEL

KASIDIH LAND PARCEL 2
SITE PLAN
KASIDIH LAND PARCEL 1

NOTE :- Although community centre has been shown in the drawing this structure will be constructed later for which separate tender will be floated. The contractor has to prepare site plan in such a way that the community centre is located centrally which can be approached by the residents without much hurdles.
NOTE: Although community centre has been shown in the drawing this structure will be constructed later for which separate tender will be floated. The contractor has to prepare site plan in such a way that the community centre is located centrally which can be approached by the residents without much hurdles.
PRELIMINARY SUB-SURFACE INVESTIGATION REPORT

PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI, PLOT: 324/326/334/352/358, ADITYAPUR
PRELIMINARY SUB-SURFACE INVESTIGATION REPORT

PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI, PLOT:
324/326/334/352/358, ADITYAPUR

Job Code: S1011017

SUBMITTED TO:

CONSULTANT: SREI INFRASTRUCTURE FINANCE LTD. 'VISHWAKARMA' 86, C TOPIA ROAD (SOUTH,) KOLKATA-700046

CLIENT: JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT COMPANY LTD.

INVESTIGATIONS DONE BY:

Sun-Tech
HI-230, HARMU HOUSING COLONY, RANCHI-02,
40-P, TUPUDANA INDUSTRIAL AREA, RANCHI-03JHARKHAND
TEL: 07808266661/2/3/4/5
E-MAIL: sun.tech.lab@gmail.com, VISIT US AT: www.suntech.co.in

THE LABORATORY TESTS WERE CONDUCTED AT OUR LABORATORY NABL ACCREDITED (ISO/IEC 17025:2005) AT 40-P TUPUDANA INDUSTRIAL AREA, RANCHI-834003, JHARKHAND.
# Table Of Contents

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2.0 FIELD INVESTIGATIONS---------------------------- 6

3.0 LABORATORY TESTS------------------------------- 8

4.0 FOUNDATION ANALYSIS--------------------------- 9

5.0 GENERAL SITE CONDITIONS--------------------- 12

6.0 CONCLUSION & RECOMMENDATIONS------- 16

7.0 LIMITATIONS---------------------------------------- 19

8.0 APPENDICES---------------------------------------- 20
   • BORE HOLE LOCATION PLAN
   • FIELD BORE LOGS
   • CALCULATIONS
   • LABORATORY TEST RESULTS
1. INTRODUCTION

1.1. **NAME OF PROJECT:**

PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI, PLOT: 324/326/334/352/358, ADITYAPUR

1.2. **LOCATION:**

AT KASHIDI, PLOT: 324/326/334/352/358, ADITYAPUR.

1.3. **CUSTOMER:**

**CONSULTANT:** SREI INFRASTRUCTURE FINANCE LTD. ‘VISHWAKARMA’ 86, C TOPIA ROAD (SOUTH,) KOLKATA-700046

**CLIENT:** JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT COMPANY LTD.

1.4. **PROPOSED CONSTRUCTION:**

RCC FRAMED STRUCTURE HAVING GROUND PLUS THREE/ FOUR FLOORS WITH RESEDEENTIALTYPE LOADING.

1.5. **WORK ORDER :**

SIFL/ADV/0917/074  1-09-2017

1.6. **OBJECTIVE:**

THE PURPOSE OF THIS REPORT IS INTERPRETATION OF ENGINEERING PROPERTIES OF THE SOIL/ ROCK TO PROVIDE GEOTECHNICAL FEASIBILITY AND RECOMMENDATIONS REGARDING DESIGN OF FOUNDATION OF THE PROJECT.

1.7. **SCHEDULE OF TESTING:**

MARCH.-2018
1.8. **PURPOSES OF STUDY**

The overall purpose of these investigations was to present soil Stratigraphy of the proposed location and various strength parameters of soil samples recovered from the boring operations and thereby to develop geotechnical recommendation for foundation design and construction. To accomplish these purposes, the study was conducted as per the guidelines of *IS: 1892-1993* and in the following phases:

(a) **Making boreholes** through soil and up to refusal to determine site Stratigraphy and to collect disturbed and undisturbed soil samples for laboratory testing;

(b) **Testing** selected soil samples in the laboratory to determine pertinent index and engineering properties; and

(c) **Analyzing** all field and laboratory data to develop foundation design and construction recommendations

1.9 **PLANNING OF GEOTECHNICAL INVESTIGATION**

On the basis of nature of the project, it was decided to carry out soil exploration in order to:

(i) obtain soil samples, both representative and undisturbed (wherever necessary) for classification tests and other laboratory tests for determining engineering properties;

(ii) obtain soundings of penetration resistance by Standard Penetration test (as per IS:2131-1981) in the boreholes;
2. FIELD INVESTIGATION

2.1. SOIL BORINGS

The boreholes were progressed using a hand operated auger to the Specified depth or refusal, whichever is encountered earlier. The diameter of the borehole was 150 mm. Where caving of the borehole occurred, casing was used to keep the borehole stable. The work was in general accordance IS: 1892-1979.

Standard Penetration Test (SPT) was conducted in the borehole at 1.5 m interval by connecting a split spoon sampler to ‘A’ rods and driving it by 45 cm. The tests were conducted in accordance with IS: 2131-1981.

The numbers of blows for each 15 cm of penetration were recorded. The blows required to penetrate the initial 15 cm of the split spoon for seating the sampler is ignored due to the possible presence of loose materials or cuttings from the drilling operation. The cumulative number of blows required to penetrate the balance 30 cm of the 45 cm sampling interval is termed the SPT value of the ‘N’ value.

The ‘N’ values are presented on the profiles for each borehole. Refusal to further boring penetration was considered when the ‘N’ values exceed 50 or when practical refusal to further penetration by shell and auger was encountered.

Where the ‘N’ value exceeds 50, the penetration of split spoon sampler (after initial seating) is recorded together with the number of blows given of the sampler. Where the seating blow count exceeds 50, the ‘N’ value is recorded as “Ref” on the soil profile. *SPT ‘N’ values are correlated with relative density of non-cohesive stratum and with consistency of cohesive stratum:*

<table>
<thead>
<tr>
<th>CONSISTENCY</th>
<th>PENETRATION VALUE (BLOWS)</th>
<th>PENETRATION VALUE (BLOWS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Soft</td>
<td>0-2</td>
<td>Very Loose</td>
</tr>
<tr>
<td>Soft</td>
<td>3-4</td>
<td>Loose</td>
</tr>
<tr>
<td>Medium Stiff</td>
<td>5-8</td>
<td>Medium</td>
</tr>
<tr>
<td>Stiff</td>
<td>9-16</td>
<td>Dense</td>
</tr>
<tr>
<td>Very stiff</td>
<td>17-32</td>
<td>Very Dense</td>
</tr>
<tr>
<td>Hard</td>
<td>&gt;32</td>
<td></td>
</tr>
</tbody>
</table>
2.2 DISTURBED SAMPLING (SOIL) IN BOREHOLES
Disturbed soil collected in the SPT sampler was preserved in polythene covers and transported to the laboratory. One more polythene cover was provided to prevent the loss of moisture during the transit period.

2.3 UNDISTURBED SAMPLING (SOIL) IN BOREHOLES
Undisturbed sampling is done in soft to stiff clayey soils. Undisturbed soil samples could not be collected in Very dense soil strata.

2.4 GROUNDWATER
Groundwater level was measured in the boreholes 24 hours after drilling and sampling was completed.
3. LABORATORY TESTS

The laboratory testing has been carried out at our laboratory at 40-P Tupudana Industrial Area, Tupudana Ranchi. The quality procedures in our laboratory conform to ISO/IEC-17025-2005.

The laboratory testing programme was aimed at verifying the field classifications and developing parameters for engineering analysis. All testing was performed in accordance with the current applicable IS specifications. The following tests were conducted on selected soil and water samples recovered from the borehole:

<table>
<thead>
<tr>
<th>Description of Test</th>
<th>IS : Code Referred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural moisture content</td>
<td>IS : 2720 (Part-2)-1973</td>
</tr>
<tr>
<td>Grain size analysis</td>
<td>IS : 2720 (Part-4)-1985</td>
</tr>
<tr>
<td>Liquid &amp; Plastic limit</td>
<td>IS : 2720 (Part-5)-1985</td>
</tr>
<tr>
<td>Specify Gravity</td>
<td>IS : 2720 (Part-3)-1980</td>
</tr>
<tr>
<td>Unconsolidated Undrained Triaxial shear test</td>
<td>IS : 2720 (Part-11)-1983</td>
</tr>
<tr>
<td>Chemical Analysis of soil/ water</td>
<td></td>
</tr>
<tr>
<td>Determination of pH value</td>
<td>IS : 2720 (Part-26)-1987</td>
</tr>
<tr>
<td>Determination of Sulphate content</td>
<td>IS : 2720 (Part-27)-1977</td>
</tr>
<tr>
<td>Determination Chloride content</td>
<td>IS : 3025 (Part-32)-1988</td>
</tr>
</tbody>
</table>

All test results are presented in the illustration section of this report.
FEW PICTURES SHOWING LABORATORY TESTING IN PROGRESS
4. FOUNDATION ANALYSIS

4.1 OPEN FOUNDATION

For satisfactory performance of a foundation, the following criteria must be satisfied;
(i) The foundation must not fail in shear.
(ii) The foundation must not settle by an amount more than the permissible settlement.

4.1.1 The allowable bearing capacity shall be taken as either of the following, whichever is less:

a) Net ultimate bearing capacity as obtained divided by suitable factor of safety, that is, net safe bearing capacity.

4.1.2 The net soil pressure that can be imposed on the base without the settlement exceeding the permissible values as given in IS : 1904-1978* to be determined for each structure and type of soil, that is, safe bearing pressure.

Types of soil formations are specified in IS : 1904-1978. The methods for calculations of settlements for assumed pressure from standard penetration resistance are specified in IS : 8009 (Part I)-1976; by calculating the settlements for two or three probable soil pressures and interpolating, the net soil pressure for permissible settlement may be estimated.
4.2 ALLOWABLE BEARING PRESSURE OF OPEN FOUNDATIONS
FROM SHEAR FAILURE METHOD AS PER IS:6403-1981:

IS Code (IS:6403-1981), (Sec.5.1.2) recommends a bearing capacity equation which is similar in nature to those given by Meyerhoff and Brinch Hansen. The net ultimate bearing capacity of a shallow foundation of breadth B (m) is given as per the IS code by the equation:

\[ q_{nf} = cNc \cdot sc \cdot dc \cdot ic + q(Nq-1) \cdot sq \cdot dq \cdot iq + 1/2.B.\gamma.\gamma.N\gamma.s\gamma.d\gamma.i\gamma.W' \]

The net safe bearing capacity, \( q_{ns} \), is given by (\( q_{nf} \)/factor of safety)

Where:
- \( c \) = cohesion (t/m²)
- \( q \) = effective surcharge at the base level of foundation (t/m²)
- \( sc, sq, s\gamma \) = unit weight of subsoil (t/m²)
- \( B \) = breadth of footing; \( L \) = length of footing
- \( \Phi \) = angle of internal friction of soil
- \( Df \) = depth of foundation
- \( Nc, Nq, N\gamma \) = Bearing capacity factors given in relevant tables for general shear failure.

For obtaining \( Nc', Nq', N\gamma' \) corresponding to local shear failure a reduced value of \( \Phi' = \tan^{-1}(0.67\Phi) \) and corresponding values are taken for \( Nc, Nq, N\gamma \).

\( Sc, Sq, S\gamma \) = shape factors
\( dc, dq, d\gamma \) = depth factors
\( ic, iq, i\gamma \) = inclination factors

\( W' \) = water table factor (=0.5 for water table at the footing level & 1.0 for water table at depth B below the footing, to be obtained by linear interpolation). The values of the other factors are as tabulated below:

<table>
<thead>
<tr>
<th>Shape factor</th>
<th>Sq./circ.</th>
<th>Rect.</th>
<th>Strip</th>
<th>dc=1+0.2(Df/B)(N\Phi)0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>sc</td>
<td>1.3</td>
<td>1+0.2B/L</td>
<td>1.0</td>
<td>dq=d\gamma=1 for ( \Phi &lt; 10 )</td>
</tr>
<tr>
<td>sq</td>
<td>1.2</td>
<td>1+0.2B/L</td>
<td>1.0</td>
<td>dq=d\gamma=1+0.1(N\Phi)0.5 for ( \Phi &gt; 10 )</td>
</tr>
<tr>
<td>s\gamma</td>
<td>0.8/0.6</td>
<td>1-0.4B/L</td>
<td>1.0</td>
<td>Ic=iq=i\gamma=1.0 for vertical loading</td>
</tr>
</tbody>
</table>

The net safe bearing capacity values calculated as above have to be checked for settlement in order to arrive at the net allowable bearing capacity values.
4.2.2 SAFE BEARING PRESSURE FROM SETTLEMENT CRITERIA FROM SPT N VALUES:

The net soil pressure that can be imposed on the base without the settlement exceeding the permissible values as given in IS : 1904-1978* to be determined for each structure and type of soil, that is, safe bearing pressure. Types of soil formations are specified in IS : 1904-1978. The methods for calculations of settlements for assumed pressure from standard penetration resistance are specified in IS : 8009 (Part I)-1976; by calculating the settlements for two or three probable soil pressures and interpolating, the net soil pressure for permissible settlement may be estimated.
5. GENERAL SITE CONDITIONS

5.1. GENERAL DESCRIPTION:

The boring has been done as per the approved layout plan. The sub-soil formation for the PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI, PLOT: 324/326/334/352/358, ADITYAPUR has been investigated by sinking 1 no. of borehole explored up to a depth of refusal strata.

5.2. GENERAL GEOLOGY:

The Major landforms of the area are granite gneiss. Undulating erosional surface with interrupting dykes, ridges and inselbergs are prominent features.

Valley fills- These are developed over granite gneiss. It consists of boulders, cobbles, pebbles, gravels, sandy silt and clays.

There are three well-defined seasons in region. The cold-weather season, from November to February, is the most pleasant part of the year. Lowest temperature in Jharkhand lies between -5°C to 0°C. High temperatures in December usually rise from about 50 °F (10 °C) into the low 70s F (low 20s C) daily. The hot-weather season lasts from March to mid-June. May, the hottest month, is characterized by daily high temperatures in the upper 90s F (about 37 °C) and low temperatures in the mid-70s F (mid-20s C). Maximum rainfall takes place during the months from July to September that accounts for more than 90% of total rainfall in the state.
5.3. SUB-SURFACE CONDITIONS:

The field investigation data and the results of laboratory tests conducted on the samples collected from the bore holes in general reveal similar stratification.

⇒ The detailed soil profile and various soil layers have been provided in the soil profile attached.

⇒ The soil strata is medium -plastic silty gravelly clayey strata and non-plastic sandy silt/ weathered rocks up to the depth explored.

⇒ The Bore logs in the annexure present the detailed Stratigraphy, cross sections and nature of soil at the borehole locations.

5.4. GROUND WATER CONDITIONS:

During the current subsurface exploration ground water was not found during exploration in the site. It should be noted that these observations reflect groundwater levels at the time of the field investigation and actual groundwater levels may fluctuate significantly in response to seasonal effects, regional rainfall, and other factors not observed during this investigation. There may be regional or perched water tables at greater depth. However for the design purposes the ground water level has been considered at footing level as the ground water level may rise in peak rainy season/ due to unforeseen reasons.
5.5. REGIONAL SEISMICITY:

The intensity of an earthquake at a place is a measure of the strength of shaking during the earthquake, and is indicated by a number according to the modified Mercalli Scale or M.S.K. Scale of seismic intensities.

The Zone factors ‘Z’ for various Seismic zones as per IS:1893 (P-1)-2002 is as follows:

<table>
<thead>
<tr>
<th>Seismic Zone</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic Intensity</td>
<td>LOW</td>
<td>MODERATE</td>
<td>SEVERE</td>
<td>VERY SEVERE</td>
</tr>
<tr>
<td>Z</td>
<td>0.10</td>
<td>0.16</td>
<td>0.24</td>
<td>0.36</td>
</tr>
</tbody>
</table>

The area falls under Zone-II as classified by Bureau of Indian Standards, indicating low active zone.

5.6. LIQUEFACTION:

Liquefaction is a state in saturated cohesionless soil wherein the effective shear strength is reduced to negligible value for all engineering purpose due to pore pressure caused by vibrations during an earthquake when they approach the total confining pressure. In this condition the soil tends to behave like a fluid mass.

Typically, cyclic loading of saturated soils leads to the buildup of excess pore-water pressure as a result of soil particles being rearranged with a tendency toward denser packing. Under undrained conditions (such as during earthquake shaking), loads are transferred from the soil skeleton to the pore-water with consequent reduction in the soils' shear strength.

Liquefaction-induced ground settlement and lateral spreading have been the primary cause for extensive damage to aboveground structures, foundations and pipelines during many earthquakes.

5.7. LIQUEFACTION ASSESSMENT

Subsurface consists of silty sand with high standard penetration resistance, followed by dense rocky strata, hence site may be classified as “Liquefaction unlikely” in earthquake event.
6. CONCLUSIONS AND RECOMMENDATIONS

The foundation shall be designed to withstand the worst combinations of loads and forces. The foundation depth shall also be sufficient from consideration of bearing capacity, settlement, liquefaction potential, stability and suitability of strata at the founding level and sufficient depth below it.

Considering the soil strata encountered shallow open foundation is recommended for the foundations.

6.1 SHALLOW FOUNDATIONS

Bearing capacity analysis for open foundations bearing on soils at site has been done in accordance with IS: 6403-1981 & IS 8009 (Part-1) 1976 based on laboratory and field tests.

RECOMMENDED NET ALLOWABLE BEARING PRESSURE HAS BEEN PROVIDED FOR BUILDING:

PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI, PLOT: 324/326/334/352/358, ADITYAPUR

Notes:

⇒ It has been found that the water table will rise to 3.00 from EGL during the peak rainy season.

⇒ A maximum settlement of 40mm is expected.

⇒ The depth of embedment of foundation has been given from the existing ground level any cutting or filling at that point should be adequately taken care of.

⇒ The detailed calculations have been annexed with this report.

⇒ Detail geotechnical investigation is recommended at the actual building location prior to construction work.
### Recommended Net Allowable Bearing Pressure

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth of Foundation (m)</th>
<th>Type of Foundation</th>
<th>RL of Bore Hole Top (m)</th>
<th>RL of Foundation Level (m)</th>
<th>Recommended Net Allowable Bearing Pressure (kN/m²)</th>
<th>Founding Strata</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI, PLOT: 324/326/334/352/358, SARAIKELA (BH-1)</td>
<td>1.50</td>
<td>OPEN/ ISOLATED</td>
<td>100.00</td>
<td>98.50</td>
<td>120.00</td>
<td>SILTY GRAVELLY CLAY</td>
</tr>
<tr>
<td></td>
<td>1.80</td>
<td>OPEN/ ISOLATED</td>
<td>100.00</td>
<td>98.20</td>
<td>130.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>OPEN/ ISOLATED</td>
<td>100.00</td>
<td>98.00</td>
<td>150.00</td>
<td></td>
</tr>
</tbody>
</table>

**Maximum Permissible Settlement: 40mm**
6.2 CONSTRUCTION CONSIDERATIONS

6.2.1 Site Work Preparation:

Prior to construction of any new foundations, all areas that will receive fill, base rock, or structures should be stripped of all surface vegetation, organic topsoil, and any deleterious materials that might be encountered. Any soft or unsuitable soils encountered during stripping or excavation should be removed and replaced with structural fill meeting the requirements.

6.2.2 Shallow Foundation Excavation:

We recommend that excavations for foundations in soil and weathered rock be accomplished with a straight-edged grading bucket to minimize disturbance of the bearing surfaces. Following excavation, the bearing surfaces should be thoroughly cleaned of loosened or disturbed soil, by hand if necessary. Any soft or unsuitable soils encountered at the base of foundation excavation should be removed and replaced with compacted structural fill.

The temporary excavation is expected to be through the Silty gravelly clayey soil.

<table>
<thead>
<tr>
<th>DESCRIPTION OF STRATA</th>
<th>RECOMMENDED SIDE SLOPES</th>
<th>EXCAVATION METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILTY GRAVELLY CLAY</td>
<td>1V:2H</td>
<td>Conventional Excavators</td>
</tr>
</tbody>
</table>

6.2.3 Cement:

Chemical analyses of sub-soil water and soil samples were carried out and pH, Chloride and Sulphate values were calculated. The result of chemical analysis of subsoil sample indicate that the pH value, sulphate content, chloride content are within permissible limit and the RCC work prepared with Ordinary Portland Cement shall not be deteriorated when placed over/within site subsoil.
7. LIMITATIONS

This report presents recommendations pertaining to the proposed structures as represented to Sun-Tech, as described herein. The findings and recommendations presented in this report are based upon soil conditions observed the available subsurface explorations, interpolation of the soil conditions between test pits, and extrapolation of these conditions throughout the proposed site area. They are further based on the assumption that the subsurface conditions do not deviate appreciably from those reported and those assumed. However, the possibility of different conditions cannot be discounted. In the event that changes in design loads or structural characteristics described in this report are made, Sun-Tech should be retained to review our design recommendations and their applicability to the revised design plans. In this way, any required supplemental recommendations can be made in a timely manner.

This report has been prepared for the specific project, purpose, and customer stated in the report; the report may not be adequate for other uses. The use of the recommendations of this report for other projects or purposes or by other parties is not authorized.

Although Sun-Tech has endeavored to characterize the surface and subsurface conditions at the site, Sun-Tech is not as able to assess potential construction difficulties as is a contractor specializing in the work to be performed. Consequently, the Contractor is responsible, and Sun-Tech is not, for final evaluation of potential construction difficulties.

This report has been prepared in accordance with the care and skill generally exercised at the present time by reputable professionals in the field of geotechnical engineering, under similar circumstances, for projects in the project locality. No other warranty, either expressed or implied, is made as to the professional advice presented herein.

For Sun-Tech, Ranchi

(Pranay Kumar)
8. LIST OF APPENDICES

8.1 Bore Hole Location

8.2 Field Bore Log Data Sheet

8.3 Calculations

8.4 Laboratory Test Results
# Bore-Log Sheet

**Project:** PMAY  
**Type of boring:** Manual/Mech. Auger  
**Depth of boring:** 4.00 m  
**Type of drilling:** SPT  
**Structure:** RCC Framed  
**Location:** Kashidi Plot-324 Etc.  
**Ground RL:** 100.00 m  
**Date:** 16.03.2018  
**Starting time:** 09.00 AM  
**Completion time:** 6.00 PM  
**Water struck at:** Not found  
**Done by:** S.B.PD.  

**Test Method:** IS 2131:1981  
**DOC NO.:** F01(5.4)SF-1

### Standard Penetration Test

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Graphic Log</th>
<th>Depth</th>
<th>Standard Penetration Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stiff medium-plasticity, inorganic, yellowish silty gravelly clayey soil.</td>
<td>CI</td>
<td></td>
<td>0.0</td>
<td>4 4 6 10</td>
</tr>
<tr>
<td>Very dense yellowish non-plastic sandy silt, inorganic soil / weathered</td>
<td>SM</td>
<td></td>
<td>3.0</td>
<td>9 9 12 21</td>
</tr>
<tr>
<td>rocks. (2.50-4.00m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very dense weathered rock strata.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Refusal:** N=100 for penetration of 15 cm

**Termination:**
## SUMMARY OF CALCULATIONS

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>RL (m) OF BORE HOLE TOP</th>
<th>DEPTH (m)</th>
<th>RL (m) OF FOUNDATION LEVEL</th>
<th>SIZE OF FOUNDATION (m)</th>
<th>TYPE OF SHEAR FAILURE</th>
<th>C kg/cm²</th>
<th>degree</th>
<th>γ g/cc</th>
<th>Net Safe Bearing Capacity ton/m²</th>
<th>Average SPT N value</th>
<th>NET ALLOWABLE BEARING PRESSURE (qap40) FOR A SETTLEMENT OF 40 mm IN ton/m²</th>
<th>RECOMMENDED NET ALLOWABLE BEARING PRESSURE (ton/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI, PLOT: 324/326/334/352/358, SARAIKELA (BH-1)</td>
<td>100.00</td>
<td>1.50</td>
<td>98.50</td>
<td>3.00 3.00</td>
<td>GENERAL</td>
<td>0.20</td>
<td>15.00</td>
<td>2.04</td>
<td>14</td>
<td>16</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI, PLOT: 324/326/334/352/358, SARAIKELA (BH-1)</td>
<td>100.00</td>
<td>1.80</td>
<td>98.20</td>
<td>3.00 3.00</td>
<td>GENERAL</td>
<td>0.20</td>
<td>15.00</td>
<td>2.04</td>
<td>15</td>
<td>17</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI, PLOT: 324/326/334/352/358, SARAIKELA (BH-1)</td>
<td>100.00</td>
<td>2.00</td>
<td>98.00</td>
<td>3.00 3.00</td>
<td>GENERAL</td>
<td>0.20</td>
<td>15.00</td>
<td>2.04</td>
<td>15</td>
<td>20</td>
<td>16</td>
<td>15</td>
</tr>
</tbody>
</table>
### SHEAR ANALYSIS AS PER IS: 6403-1981

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Depth (m)</th>
<th>Width (m)</th>
<th>Length (m)</th>
<th>Cohesion c kg/cm²</th>
<th>Angle of Repose (Degree)</th>
<th>Shape factor</th>
<th>Bearing Capacity Factors</th>
<th>Water Table correction</th>
<th>Ultimate Bearing Capacity t/m²</th>
<th>Net safe Bearing Capacity t/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sc</td>
<td>Sq</td>
<td>Sγ</td>
<td>Nc</td>
<td>Nq</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.30</td>
<td>1.20</td>
<td>0.80</td>
<td>10.98</td>
<td>3.94</td>
</tr>
<tr>
<td></td>
<td>1.50</td>
<td>3.00</td>
<td>3.00</td>
<td>0.20</td>
<td>15.00</td>
<td>2.04</td>
<td>Nc</td>
<td>Nq</td>
<td>Ny</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.80</td>
<td>3.00</td>
<td>3.00</td>
<td>0.20</td>
<td>15.00</td>
<td>2.04</td>
<td>Nc</td>
<td>Nq</td>
<td>Ny</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>3.00</td>
<td>3.00</td>
<td>0.20</td>
<td>15.00</td>
<td>2.04</td>
<td>Nc</td>
<td>Nq</td>
<td>Ny</td>
<td></td>
</tr>
</tbody>
</table>

ASSUMPTIONS: ASSUMING GENERAL SHEAR FAILURE CONDITIONS AS PER IS:6403-1981. FACTOR OF SAFETY: 3.00 DEPTH FACTOR TAKEN AS 1.00
### SETTLEMENT ANALYSIS FOR SHALLOW FOUNDATIONS BASED ON SPT N VALUES IS:8009 (Part-1)-1976, Cl. 9.1.4

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Depth of Foundation (m)</th>
<th>SIZE OF FOUNDATION</th>
<th>SPT Design Value</th>
<th>Water table correction Rw</th>
<th>Settlement @ 1.00kg/cm² (as read from graph) mm</th>
<th>Fox's Depth Factor</th>
<th>Rigidity Factor dr</th>
<th>NET ALLOWABLE BEARING PRESSURE (qap40) FOR A SETTLEMENT OF 40 mm IN ton/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.50</td>
<td>3.00</td>
<td>3.00</td>
<td>16.00</td>
<td>0.50</td>
<td>20.00</td>
<td>0.80</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>1.80</td>
<td>3.00</td>
<td>3.00</td>
<td>17.00</td>
<td>0.50</td>
<td>19.00</td>
<td>0.78</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>3.00</td>
<td>3.00</td>
<td>20.00</td>
<td>0.50</td>
<td>16.00</td>
<td>0.78</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Design Water Depth:**
- Ground level

**Rw factor considering worst condition:** 0.500

**Fox's Depth Factor to be considered:** yes

**Depth to be ignored in Depth Factor Computation for loose soil:** yes

**Tolerable settlement (mm):** 40.00
### Laboratory Test Results on Soil Samples

<table>
<thead>
<tr>
<th>BH No.</th>
<th>Sample Type</th>
<th>Sample Number</th>
<th>Depth (m)</th>
<th>Grain Size Distribution</th>
<th>Soil Test Results</th>
<th>Chemical Test</th>
<th>Consolidation Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-1</td>
<td>U</td>
<td>1/1</td>
<td>1.50</td>
<td>3.30 41.85 15.00 36.40 18.75 17.65</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Laboratory Test Results**

- **U**: Triaxial Unconsolidated Undrained
- **TCU**: Triaxial Consolidated Undrained
- **TCD**: Triaxial Consolidated Drained
- **DS**: Direct Shear
- **UC**: Unconfined Compressive

**Notes:**

- **Borehole Sample:** Samples from Bore holes
- **P**: SPT Sample
- **D**: Disturbed/ Wash Sample
- **U**: Un-Disturbed Sample

**Chemical Tests**

- **pH**: 6.5-8.5
- **Chloride**: 2000 mg/l max.
- **Sulfate**: 400 mg/l max.

**Consolidation Tests**

- **Specific Gravity**: 1.85
- **Natural Moisture Content %**: 15.00
- **Bulk Density (gm/cc)**: 1.25

**Classification (IS:1498-1970)**

- **Natural Moisture Content %**: 15.00
- **Bulk Density (gm/cc)**: 1.25

**Project:** PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI, PLOT: 324/326/334/352/358, SARAIKELA

**Authorised Signatory:**

(Pranay Kumar)
PRELIMINARY SUB-SURFACE INVESTIGATION REPORT

PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI PLOT NO. 242, ADITYAPUR, GAMARIA
PRELIMINARY SUB-SURFACE INVESTIGATION REPORT
PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI PLOT NO. 242, ADITYAPUR, GAMARIA

Job Code: S1011017

SUBMITTED TO:

CONSULTANT: SREI INFRASTRUCTURE FINANCE LTD. 'VISHWAKARMA' 86, C TOPIA ROAD (SOUTH,) KOLKATA-700046

CLIENT: JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT COMPANY LTD.

INVESTIGATIONS DONE BY:

Sun-Tech
HI-230, HARMU HOUSING COLONY, RANCHI-02, 40-P, TUPUDANA INDUSTRIAL AREA, RANCHI-03 JHARKHAND
TEL: 07808266661/2/3/4/5
E-MAIL: sun.tech.lab@gmail.com, VISIT US AT: www.suntech.co.in

THE LABORATORY TESTS WERE CONDUCTED AT OUR LABORATORY NABL ACCREDITED (ISO/IEC 17025:2005) AT 40-P TUPUDANA INDUSTRIAL AREA, RANCHI-834003, JHARKHAND.
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1.0 INTRODUCTION-------------------------------------- 4

2.0 FIELD INVESTIGATIONS----------------------------- 6

3.0 LABORATORY TESTS-------------------------------- 8

4.0 FOUNDATION ANALYSIS------------------------------- 9

5.0 GENERAL SITE CONDITIONS------------------------- 12

6.0 CONCLUSION & RECOMMENDATIONS------------------- 16

7.0 LIMITATIONS---------------------------------------- 19

8.0 APPEDICES---------------------------------------- 20
  • BORE HOLE LOCATION PLAN
  • FIELD BORE LOGS
  • CALCULATIONS
  • LABORATORY TEST RESULTS
1. INTRODUCTION

1.1. **NAME OF PROJECT:**

AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI PLOT NO. 242, ADITYAPUR, GAMARIA,

1.2. **LOCATION:**

AT KASHIDI PLOT NO. 242, ADITYAPUR, GAMARIA.

1.3. **CUSTOMER:**

**CONSULTANT:** SREI INFRASTRUCTURE FINANCE LTD. 'VISHWAKARMA' 86, C TOPIA ROAD (SOUTH,) KOLKATA-700046
**CLIENT:** JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT COMPANY LTD..

1.4. **PROPOSED CONSTRUCTION:**

RCC FRAMED STRUCTURE HAVING GROUND PLUS THREE/ FOUR FLOORS WITH RESEDENTIALTYPE LOADING.

1.5. **WORK ORDER :**

SIFL/ADV/0917/074 1-09-2017

1.6. **OBJECTIVE:**

THE PURPOSE OF THIS REPORT IS INTERPRETATION OF ENGINEERING PROPERTIES OF THE SOIL/ ROCK TO PROVIDE GEOTECHNICAL FEASIBILITY AND RECOMMENDATIONS REGARDING DESIGN OF FOUNDATION OF THE PROJECT.

1.7. **SCHEDULE OF TESTING:**

MARCH.-2018
1.8. **PURPOSES OF STUDY**

The overall purpose of these investigations was to present soil Stratigraphy of the proposed location and various strength parameters of soil samples recovered from the boring operations and thereby to develop geotechnical recommendation for foundation design and construction. To accomplish these purposes, the study was conducted as per the guidelines of *IS: 1892-1993* and in the following phases:

(a) **Making boreholes** through soil and up to refusal to determine site Stratigraphy and to collect disturbed and undisturbed soil samples for laboratory testing;

(b) **Testing** selected soil samples in the laboratory to determine pertinent index and engineering properties; and

(c) **Analyzing** all field and laboratory data to develop foundation design and construction recommendations

**1.9 PLANNING OF GEOTECHNICAL INVESTIGATION**

On the basis of nature of the project, it was decided to carry out soil exploration in order to:

(i) obtain soil samples, both representative and undisturbed (wherever necessary) for classification tests and other laboratory tests for determining engineering properties;

(ii) obtain soundings of penetration resistance by Standard Penetration test (as per IS:2131-1981) in the boreholes;
2. FIELD INVESTIGATION

2.1. **SOIL BORINGS**

The boreholes were progressed using a hand operated auger to the Specified depth or refusal, whichever is encountered earlier. The diameter of the borehole was 150 mm. Where caving of the borehole occurred, casing was used to keep the borehole stable. The work was in general accordance IS: 1892-1979.

Standard Penetration Test (SPT) was conducted in the borehole at 1.5 m interval by connecting a split spoon sampler to ‘A’ rods and driving it by 45 cm. The tests were conducted in accordance with IS: 2131-1981.

The numbers of blows for each 15 cm of penetration were recorded. The blows required to penetrate the initial 15 cm of the split spoon for seating the sampler is ignored due to the possible presence of loose materials or cuttings from the drilling operation. The cumulative number of blows required to penetrate the balance 30 cm of the 45 cm sampling interval is termed the SPT value of the ‘N’ value.

The ‘N’ values are presented on the profiles for each borehole. Refusal to further boring penetration was considered when the ‘N’ values exceed 50 or when practical refusal to further penetration by shell and auger was encountered.

Where the ‘N’ value exceeds 50, the penetration of split spoon sampler (after initial seating) is recorded together with the number of blows given of the sampler. Where the seating blow count exceeds 50, the ‘N’ value is recorded as “Ref” on the soil profile. **SPT ‘N’ values are correlated with relative density of non-cohesive stratum and with consistency of cohesive stratum:**

<table>
<thead>
<tr>
<th>Consistency</th>
<th>Penetration Value (blows)</th>
<th>Relative Density</th>
<th>Penetration Value (blows)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Soft</td>
<td>0-2</td>
<td>Very Loose</td>
<td>0-4</td>
</tr>
<tr>
<td>Soft</td>
<td>3-4</td>
<td>Loose</td>
<td>5-10</td>
</tr>
<tr>
<td>Medium Stiff</td>
<td>5-8</td>
<td>Medium</td>
<td>11-30</td>
</tr>
<tr>
<td>Stiff</td>
<td>9-16</td>
<td>Dense</td>
<td>31-50</td>
</tr>
<tr>
<td>Very stiff</td>
<td>17-32</td>
<td>Very Dense</td>
<td>&gt;50</td>
</tr>
<tr>
<td>Hard</td>
<td>&gt;32</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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2.2 DISTURBED SAMPLING (SOIL) IN BOREHOLES

Disturbed soil collected in the SPT sampler was preserved in polythene covers and transported to the laboratory. One more polythene cover was provided to prevent the loss of moisture during the transit period.

2.3 UNDISTURBED SAMPLING (SOIL) IN BOREHOLES

Undisturbed sampling is done in soft to stiff clayey soils. Undisturbed soil samples could not be collected in Very dense soil strata.

2.4 GROUNDWATER

Groundwater level was measured in the boreholes 24 hours after drilling and sampling was completed.
3. LABORATORY TESTS

The laboratory testing has been carried out at our laboratory at 40-P Tupudana Industrial Area, Tupudana Ranchi. The quality procedures in our laboratory conform to ISO/IEC-17025-2005.

The laboratory testing programme was aimed at verifying the field classifications and developing parameters for engineering analysis. All testing was performed in accordance with the current applicable IS specifications. The following tests were conducted on selected soil and water samples recovered from the borehole:

<table>
<thead>
<tr>
<th>Description of Test</th>
<th>IS : Code Referred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural moisture content</td>
<td>IS : 2720 (Part-2)-1973</td>
</tr>
<tr>
<td>Grain size analysis</td>
<td>IS : 2720 (Part-4)-1985</td>
</tr>
<tr>
<td>Liquid &amp; Plastic limit</td>
<td>IS : 2720 (Part-5)-1985</td>
</tr>
<tr>
<td>Specify Gravity</td>
<td>IS : 2720 (Part-3)-1980</td>
</tr>
<tr>
<td>Unconsolidated Undrained Triaxial shear test</td>
<td>IS : 2720 (Part-11)-1983</td>
</tr>
<tr>
<td>Chemical Analysis of soil/ water</td>
<td></td>
</tr>
<tr>
<td>Determination of pH value</td>
<td>IS : 2720 (Part-26)-1987</td>
</tr>
<tr>
<td>Determination of Sulphate content</td>
<td>IS : 2720 (Part-27)-1977</td>
</tr>
<tr>
<td>Determination Chloride content</td>
<td>IS : 3025 (Part-32)-1988</td>
</tr>
</tbody>
</table>

All test results are presented in the illustration section of this report.
FEW PICTURES SHOWING LABORATORY TESTING IN PROGRESS
4. FOUNDATION ANALYSIS

4.1 OPEN FOUNDATION

For satisfactory performance of a foundation, the following criteria must be satisfied;

(i) The foundation must not fail in shear.

(ii) The foundation must not settle by an amount more than the permissible settlement.

4.1.1 The allowable bearing capacity shall be taken as either of the following, whichever is less:

a) Net ultimate bearing capacity as obtained divided by suitable factor of safety, that is, net safe bearing capacity.

4.1.2 The net soil pressure that can be imposed on the base without the settlement exceeding the permissible values as given in IS : 1904-1978* to be determined for each structure and type of soil, that is, safe bearing pressure.

Types of soil formations are specified in IS : 1904-1978. The methods for calculations of settlements for assumed pressure from standard penetration resistance are specified in IS : 8009 (Part I)-1976; by calculating the settlements for two or three probable soil pressures and interpolating, the net soil pressure for permissible settlement may be estimated.
4.2 ALLOWABLE BEARING PRESSURE OF OPEN FOUNDATIONS
FROM SHEAR FAILURE METHOD AS PER IS:6403-1981 :

IS Code (IS:6403-1981), (Sec.5.1.2) recommends a bearing capacity equation which is similar in nature to those given by Meyerhoff and Brinch Hansen. The net ultimate bearing capacity of a shallow foundation of breadth B (m) is given as per the IS code by the equation:

\[ q_{nf} = cN_csc_{dc}ic + q(Nq-1)sqsq_{dq}iq + 1/2.B.\gamma.N_\gamma.s_\gamma.d_\gamma.i_\gamma.W' \]

The net safe bearing capacity, \( q_{ns} \) = \( q_{nf} \)/ factor of safety

Where  
- \( c \) = cohesion (t/m\(^2\))  
- \( q \) = effective surcharge at the base level of foundation ( t/m\(^2\))  
- \( s_c \) = unit weight of subsoil (t/m\(^2\))  
- \( B \) = breadth of footing; \( L \) = length of footing  
- \( \phi \) = angle of internal friction of soil  
- \( D_f \) = depth of foundation  
- \( N_c, N_q, N_\gamma \) = Bearing capacity factors given in relevant tables for general shear failure. For obtaining \( N_c', N_q', N_\gamma' \) corresponding to local shear failure a reduced value of \( \phi' = \tan^{-1}(0.67 \phi) \) and corresponding values are taken for \( N_c, N_q, N_\gamma \).

- \( S_c, S_q, S_\gamma \) = shape factors  
- \( d_c, d_q, d_\gamma \) = depth factors  
- \( i_c, i_q, i_\gamma \) = inclination factors

\( W' \) = water table factor (=0.5 for water table at the footing level & 1.0 for water table at depth B below the footing, to be obtained by linear interpolation). The values of the other factors are as tabulated below:

<table>
<thead>
<tr>
<th>Shape factor</th>
<th>Sq./circ.</th>
<th>Rect.</th>
<th>Strip</th>
<th>dc=1+0.2(Df/B)(N\phi)0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>sc</td>
<td>1.3</td>
<td>1+0.2B/L</td>
<td>1.0</td>
<td>dq=d_\gamma=1 for \phi&lt;10</td>
</tr>
<tr>
<td>sq</td>
<td>1.2</td>
<td>1+0.2B/L</td>
<td>1.0</td>
<td>dq=d_\gamma=1+0.1(N\phi)0.5 for \phi&gt;10</td>
</tr>
<tr>
<td>s_\gamma</td>
<td>0.8/0.6</td>
<td>1-0.4B/L</td>
<td>1.0</td>
<td>Ic=i_q=i_\gamma=1.0 for vertical loading</td>
</tr>
</tbody>
</table>

The net safe bearing capacity values calculated as above have to be checked for settlement in order to arrive at the net allowable bearing capacity values.
4.2.2 SAFE BEARING PRESSURE FROM SETTLEMENT CRITERIA
FROM SPT N VALUES:

The net soil pressure that can be imposed on the base without the settlement exceeding the permissible values as given in IS : 1904-1978* to be determined for each structure and type of soil, that is, safe bearing pressure. Types of soil formations are specified in IS : 1904-1978. The methods for calculations of settlements for assumed pressure from standard penetration resistance are specified in IS : 8009 (Part I)-1976; by calculating the settlements for two or three probable soil pressures and interpolating, the net soil pressure for permissible settlement may be estimated.
5. GENERAL SITE CONDITIONS

5.1. GENERAL DESCRIPTION:

The boring has been done as per the approved layout plan. The sub-soil formation for the PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI PLOT NO. 242, GAMARIA has been investigated by sinking 1 no. of borehole explored up to a depth of refusal strata.

5.2. GENERAL GEOLOGY:

The Major landforms of the area are granite gneiss. Undulating erosional surface with interrupting dykes, ridges and inselbergs are prominent features. Valley fills- These are developed over granite gneiss. It consists of boulders, cobbles, pebbles, gravels, sandy silt and clays.

There are three well-defined seasons in region. The cold-weather season, from November to February, is the most pleasant part of the year. Lowest temperature in Jharkhand lies between -5°C to 0°C. High temperatures in December usually rise from about 50 °F (10 °C) into the low 70s F (low 20s C) daily. The hot-weather season lasts from March to mid-June. May, the hottest month, is characterized by daily high temperatures in the upper 90s F (about 37 °C) and low temperatures in the mid-70s F (mid-20s C). Maximum rainfall takes place during the months from July to September that accounts for more than 90% of total rainfall in the state.
5.3. SUB-SURFACE CONDITIONS:

The field investigation data and the results of laboratory tests conducted on the samples collected from the bore holes in general reveal similar stratification.

- The detailed soil profile and various soil layers have been provided in the soil profile attached.
- The soil strata is medium -plastic silty gravelly clayey strata and non-plastic sandy silt/ weathered rocks up to the depth explored.
- The Bore logs in the annexure present the detailed Stratigraphy, cross sections and nature of soil at the borehole locations.

5.4. GROUND WATER CONDITIONS:

During the current subsurface exploration ground water was not found during exploration in the site. It should be noted that these observations reflect groundwater levels at the time of the field investigation and actual groundwater levels may fluctuate significantly in response to seasonal effects, regional rainfall, and other factors not observed during this investigation. There may be regional or perched water tables at greater depth. However for the design purposes the ground water level has been considered at footing level as the ground water level may rise in peak rainy season/ due to unforeseen reasons.
5.5. REGIONAL SEISMICITY:

The intensity of an earthquake at a place is a measure of the strength of shaking during the earthquake, and is indicated by a number according to the modified Mercalli Scale or M.S.K. Scale of seismic intensities.

The Zone factors ‘Z’ for various Seismic zones as per IS:1893 (P-1)-2002 is as follows:

<table>
<thead>
<tr>
<th>Seismic Zone</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic Intensity</td>
<td>LOW</td>
<td>MODERATE</td>
<td>SEVERE</td>
<td>VERY SEVERE</td>
</tr>
<tr>
<td>Z</td>
<td>0.10</td>
<td>0.16</td>
<td>0.24</td>
<td>0.36</td>
</tr>
</tbody>
</table>

The area falls under **Zone-II** as classified by Bureau of Indian Standards, indicating low active zone.

5.6. LIQUEFACTION:

Liquefaction is a state in saturated cohesionless soil wherein the effective shear strength is reduced to negligible value for all engineering purpose due to pore pressure caused by vibrations during an earthquake when they approach the total confining pressure. In this condition the soil tends to behave like a fluid mass.

Typically, cyclic loading of saturated soils leads to the buildup of excess pore-water pressure as a result of soil particles being rearranged with a tendency toward denser packing. Under undrained conditions (such as during earthquake shaking), loads are transferred from the soil skeleton to the pore-water with consequent reduction in the soils’ shear strength.

Liquefaction-induced ground settlement and lateral spreading have been the primary cause for extensive damage to aboveground structures, foundations and pipelines during many earthquakes.

5.7. LIQUEFACTION ASSESSMENT

Subsurface consists of silty sand with high standard penetration resistance, followed by dense rocky strata, hence site may be classified as “**Liquefaction unlikely**” in earthquake event.
6. CONCLUSIONS AND RECOMMENDATIONS

The foundation shall be designed to withstand the worst combinations of loads and forces. The foundation depth shall also be sufficient from consideration of bearing capacity, settlement, liquefaction potential, stability and suitability of strata at the founding level and sufficient depth below it.

Considering the soil strata encountered shallow open foundation is recommended for the foundations.

6.1 SHALLOW FOUNDATIONS

Bearing capacity analysis for open foundations bearing on soils at site has been done in accordance with IS: 6403-1981 & IS 8009 (Part-1) 1976 based on laboratory and field tests.

RECOMMENDED NET ALLOWABLE BEARING PRESSURE HAS BEEN PROVIDED FOR BUILDING:

PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI PLOT NO. 242, GAMARIA

Notes:

⇒ It has been found that the water table will rise to 2.50 from EGL during the peak rainy season.

⇒ A maximum settlement of 40mm is expected.

⇒ The depth of embedment of foundation has been given from the existing ground level any cutting or filling at that point should be adequately taken care of.

⇒ The detailed calculations have been annexed with this report.

⇒ Detailed geotechnical investigation is recommended at the actual building location prior to construction work.
## RECOMMENDED NET ALLOWABLE BEARING PRESSURE

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>DEPTH OF FOUNDATION (m)</th>
<th>TYPE OF FOUNDATION</th>
<th>RL OF BORE HOLE TOP (m)</th>
<th>RL OF FOUNDATION LEVEL (m)</th>
<th>RECOMMENDED NET ALLOWABLE BEARING PRESSURE (kN/m(^2))</th>
<th>FOUNDING STRATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI PLOT NO. 242, SARAIKELA, GAMARIA (BH-1)</td>
<td>1.50</td>
<td>OPEN/ ISOLATED</td>
<td>100.00</td>
<td>98.50</td>
<td>150.00</td>
<td>SILTY GRAVELLY CLAY</td>
</tr>
<tr>
<td></td>
<td>1.80</td>
<td>OPEN/ ISOLATED</td>
<td>100.00</td>
<td>98.20</td>
<td>155.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>OPEN/ ISOLATED</td>
<td>100.00</td>
<td>98.00</td>
<td>160.00</td>
<td></td>
</tr>
</tbody>
</table>

**MAXIMUM PERMISSIBLE SETTLEMENT:** 40mm
6.2 CONSTRUCTION CONSIDERATIONS

6.2.1 Site Work Preparation:

Prior to construction of any new foundations, all areas that will receive fill, base rock, or structures should be stripped of all surface vegetation, organic topsoil, and any deleterious materials that might be encountered. Any soft or unsuitable soils encountered during stripping or excavation should be removed and replaced with structural fill meeting the requirements.

6.2.2 Shallow Foundation Excavation:

We recommend that excavations for foundations in soil and weathered rock be accomplished with a straight-edged grading bucket to minimize disturbance of the bearing surfaces. Following excavation, the bearing surfaces should be thoroughly cleaned of loosened or disturbed soil, by hand if necessary. Any soft or unsuitable soils encountered at the base of foundation excavation should be removed and replaced with compacted structural fill.

The temporary excavation is expected to be through the Silty gravelly clayey soil.

<table>
<thead>
<tr>
<th>DESCRIPTION OF STRATA</th>
<th>RECOMMENDED SIDE SLOPES</th>
<th>EXCAVATION METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILTY GRAVELLY CLAY</td>
<td>1V:2H</td>
<td>Conventional Excavators</td>
</tr>
</tbody>
</table>

6.2.3 Cement:

Chemical analyses of sub-soil water and soil samples were carried out and pH, Chloride and Sulphate values were calculated. The result of chemical analysis of subsoil sample indicate that the pH value, sulphate content, chloride content are within permissible limit and the RCC work prepared with Ordinary Portland Cement shall not be deteriorated when placed over/within site subsoil.
7. LIMITATIONS

This report presents recommendations pertaining to the proposed structures as represented to Sun-Tech, as described herein. The findings and recommendations presented in this report are based upon soil conditions observed the available subsurface explorations, interpolation of the soil conditions between test pits, and extrapolation of these conditions throughout the proposed site area. They are further based on the assumption that the subsurface conditions do not deviate appreciably from those reported and those assumed. However, the possibility of different conditions cannot be discounted. In the event that changes in design loads or structural characteristics described in this report are made, Sun-Tech should be retained to review our design recommendations and their applicability to the revised design plans. In this way, any required supplemental recommendations can be made in a timely manner.

This report has been prepared for the specific project, purpose, and customer stated in the report; the report may not be adequate for other uses. The use of the recommendations of this report for other projects or purposes or by other parties is not authorized.

Although Sun-Tech has endeavored to characterize the surface and subsurface conditions at the site, Sun-Tech is not as able to assess potential construction difficulties as is a contractor specializing in the work to be performed. Consequently, the Contractor is responsible, and Sun-Tech is not, for final evaluation of potential construction difficulties. This report has been prepared in accordance with the care and skill generally exercised at the present time by reputable professionals in the field of geotechnical engineering, under similar circumstances, for projects in the project locality. No other warranty, either expressed or implied, is made as to the professional advice presented herein.

For Sun-Tech, Ranchi

(Pranay Kumar)
8. LIST OF APPENDICES

8.1 Bore Hole Location

8.2 Field Bore Log Data Sheet

8.3 Calculations

8.4 Laboratory Test Results
### BORE-LOG SHEET

**Project:** PMAY  
**Location:** KASHIDI PLOT NO. 242, SARAIXELA  
**GROUND RL:** 100.00m  
**DATE:** 15.03.2018

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SYMBOL</th>
<th>GRAPHIC LOG</th>
<th>DEPTH</th>
<th>15 cm</th>
<th>15 cm</th>
<th>15 cm</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stiff medium-plasticity, inorganic, yellowish silty gravelly claysy soil (0.00-4.50m)</td>
<td>CI</td>
<td></td>
<td>0.0</td>
<td>05</td>
<td>05</td>
<td>07</td>
<td>12</td>
</tr>
<tr>
<td>Very dense yellowish non-plastic sandy silt, inorganic soil / weathered rocks. (4.50-6.00m)</td>
<td>SM</td>
<td></td>
<td>5.0</td>
<td>13</td>
<td>15</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td>Very dense weathered rock strata.</td>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reference: N=100 for penetration of 10 cm

**TEST METHOD:** IS 2131:1981  
**DOC NO:** F01(5.4)SF-1  
**SAMPLE/TYPE:**

- **SPT:** Standard Penetration Test
- **WS:** Water Sample
- **DS:** Disturbed Sample
- **UDS:** Undisturbed Sample
- **WT:** Water Table

**Done by:** S.B.PD.

**PROJECT CODE:** S1011017

**Starting time:** 09.00 AM  
**Completion time:** 6.00 PM  
**Water struck at:** Not found
<table>
<thead>
<tr>
<th>LOCATION</th>
<th>RL (m) OF BORE HOLE TOP</th>
<th>DEPTH (m)</th>
<th>RL (m) OF FOUNDATION LEVEL</th>
<th>SIZE OF FOUNDATION (m)</th>
<th>SHEAR CRITERIA</th>
<th>SETTLEMENT CRITERIA</th>
<th>RECOMMENDED NET ALLOWABLE BEARING PRESSURE (ton/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TYPE OF SHEAR FAILURE</td>
<td>C kg/cm²</td>
<td>degree</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GENERAL</td>
<td>0.28</td>
<td>13.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GENERAL</td>
<td>0.28</td>
<td>13.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GENERAL</td>
<td>0.28</td>
<td>13.00</td>
</tr>
</tbody>
</table>
## SHEAR ANALYSIS AS PER IS: 6403-1981

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Depth (m)</th>
<th>Width (m)</th>
<th>Length (m)</th>
<th>Cohesion c kg/cm²</th>
<th>Angle of Repose (Degree)</th>
<th>Sc</th>
<th>Sq</th>
<th>Sy</th>
<th>Bulk Density g/cc</th>
<th>Bearing Capacity Factors</th>
<th>Water Table correction</th>
<th>Ultimate Bearing Capacity t/m²</th>
<th>Net safe Bearing Capacity t/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.50</td>
<td>3.00</td>
<td>3.00</td>
<td>0.28</td>
<td>13.00</td>
<td>1.30</td>
<td>1.20</td>
<td>0.80</td>
<td>1.98</td>
<td>9.81 3.26 1.97</td>
<td>0.50</td>
<td>46.11</td>
<td>15.37</td>
</tr>
<tr>
<td></td>
<td>1.80</td>
<td>3.00</td>
<td>3.00</td>
<td>0.28</td>
<td>13.00</td>
<td>1.30</td>
<td>1.20</td>
<td>0.80</td>
<td>1.98</td>
<td>9.81 3.26 1.97</td>
<td>0.50</td>
<td>47.72</td>
<td>15.91</td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>3.00</td>
<td>3.00</td>
<td>0.28</td>
<td>13.00</td>
<td>1.30</td>
<td>1.20</td>
<td>0.80</td>
<td>1.98</td>
<td>9.81 3.26 1.97</td>
<td>0.50</td>
<td>48.80</td>
<td>16.27</td>
</tr>
</tbody>
</table>

**ASSUMPTIONS:**
- FACTOR OF SAFETY: 3.00
- DEPTH FACTOR TAKEN AS 1.00

PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAAS YOJANA AT KASHIDI PLOT NO. 242, SARAIKELA, GAMARA.
<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Depth of Foundation (m)</th>
<th>SIZE OF FOUNDATION</th>
<th>SPT Design Value</th>
<th>Water table correction Rw</th>
<th>Settlement @ 1.00kg/cm² (as read from graph) mm</th>
<th>Fox's Depth Factor</th>
<th>Rigidity Factor dr</th>
<th>NET ALLOWABLE BEARING PRESSURE (q_{ap40}) FOR A SETTLEMENT OF 40 mm IN ton/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT KASHIDI PLOT NO. 242, SARAIKELA, GAMARIA (BH-1)</td>
<td>1.50</td>
<td>3.00</td>
<td>3.00</td>
<td>19.00</td>
<td>0.50</td>
<td>17.00</td>
<td>0.80</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>1.80</td>
<td>3.00</td>
<td>3.00</td>
<td>20.00</td>
<td>0.50</td>
<td>16.00</td>
<td>0.78</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>3.00</td>
<td>3.00</td>
<td>22.00</td>
<td>0.50</td>
<td>14.40</td>
<td>0.78</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Design Water Depth : Ground level
Rw factor considering worst condition : 0.50
Fox's Depth Factor to be considered : yes
Depth to be ignored in Depth Factor Computation for loose soil : yes
Tolerable settlement (mm) : 40.00
### Laboratory Test Results on Soil Samples

<table>
<thead>
<tr>
<th>BH No.</th>
<th>Sample Type</th>
<th>Sample Number</th>
<th>Depth (m)</th>
<th>Grain Size Distribution</th>
<th>Shear Strength Test</th>
<th>Chemical Test</th>
<th>Consolidation Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BH-1</td>
<td>U</td>
<td>1/1</td>
<td>1.50</td>
<td>1.06 37.53 39.41 22.00</td>
<td>-</td>
<td>CI 14.25</td>
<td>1.98 2.61</td>
</tr>
</tbody>
</table>

|               |                |                |           |                |                   |               |                   |
|               |                |                |           |                |                   |               |                   |
|               |                |                |           |                |                   |               |                   |

### Notes:
- **Test Methods Referred to:**
  1. Grain Size Distribution IS:2720 Part-4-1985
  3. Specific Gravity IS:2720 Part-3-1980
  4. Direct Shear Test IS:2720-Part-13 1986
  5. Triaxial Test IS:2720 Part-12 1981
  7. pH of Soil IS:2720- Part-41 1976

### Limits as per IS 456-2000:
- **pH:** 6.5-8.5
- **chloride:** 2000mg/l max.
- **sulfate:** 400mg/l max.
- **ND:** NOT DETECTED

### Abbreviation Used:
- UUT: Triaxial Unconsolidated Undrained
- TCU: Triaxial Consolidated Undrained
- TCD: Triaxial Consolidated Drained
- DS: Direct Shear
- UC: Unconfined Compressive

### Authorised Signatory:
(Pranay Kumar)
LOCATION MAP

LATITUDE : 22°42’10.18”N
LONGITUDE : 85°56’57.89”E

PROPOSED SITE OF PMAY V3(SARAIKELA, NORODIH)
NOTE: Although community centre has been shown in the drawing this structure will be constructed later for which separate tender will be floated. The contractor has to prepare site plan in such a way that the community centre is located centrally which can be approached by the residents without much hurdles.
TYPICAL DETAILS OF GROUND WATER RECHARGING PIT WITH SILT TANK

1. ALL DIMENSIONS ARE IN FEET & INCHES.

NOTES :-

1. ALL DIMENSIONS ARE IN FEET & INCHES.
PRELIMINARY SUB-SURFACE INVESTIGATION REPORT

PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PMAY AT SERAIKELA
(SITE: NORODIH, WARD NO:02, THANA NO: 292, ANCHAL: SERAIKELA, KHATA NO: 18, PLOT NO:801)
JUIDCO LTD., JHARKHAN

Ground Level

Super Structure

Foundation

Foundation Soil
PRELIMINARY SUB-SURFACE INVESTIGATION REPORT
PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT SERAIKELA, JHARKHAND (SITE: NORODIH, WARD NO: 02, THANA NO: 292, ANCHARA: SERAIKELA, KHATA NO: 18, PLOT NO: 801)

Job Code: S1011017

SUBMITTED TO:

CONSULTANT: SREI INFRASTRUCTURE FINANCE LTD. 'VISHWAKARMA' 86, C TOPIA ROAD (SOUTH,) KOLKATA-700046

CLIENT: JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT COMPANY LTD.

INVESTIGATIONS DONE BY:

Sun-Tech
HI-230, HARMU HOUSING COLONY, RANCHI-02,
40-P, TUPUDANA INDUSTRIAL AREA, RANCHI-03 JHARKHAND
TEL: 07808266661/2/3/4/5
E-MAIL: sun.tech.lab@gmail.com, VISIT US AT: www.suntech.co.in

THE LABORATORY TESTS WERE CONDUCTED AT OUR LABORATORY NABL ACCREDITED (ISO/IEC 17025:2005) AT 40-P TUPUDANA INDUSTRIAL AREA, RANCHI-834003, JHARKHAND.
# Table Of Contents

1.0 INTRODUCTION............................................. 4

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3.0 LABORATORY TESTS----------------------------------- 8

4.0 FOUNDATION ANALYSIS------------------------------ 9

5.0 GENERAL SITE CONDITIONS--------------------- 12

6.0 CONCLUSION & RECOMMENDATIONS-------- 16

7.0 LIMITATIONS----------------------------------------- 19

8.0 APPENDICES----------------------------------------- 20

- BORE HOLE LOCATION PLAN
- FIELD BORE LOGS
- CALCULATIONS
- LABORATORY TEST RESULTS
1. INTRODUCTION

1.1. NAME OF PROJECT:

AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT SERAIKELA,

1.2. LOCATION:

SITE : NORODIH , WARD NO:02, THANA NO : 292, ANCHAL : SERAIKELA, KHATA NO : 18 , PLOT NO:801.

1.3. CUSTOMER:

CONSULTANT: SREI INFRASTRUCTURE FINANCE LTD. 'VISHWAKARMA'
86, C TOPIA ROAD (SOUTH,) KOLKATA-700046
CLIENT: JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT COMPANY LTD..

1.4. PROPOSED CONSTRUCTION:

RCC FRAMED STRUCTURE HAVING GROUND PLUS THREE/ FOUR FLOORS WITH RESIDENTIAL TYPE LOADING.

1.5. WORK ORDER:

SIFL/ADV/0917/074 1-09-2017

1.6. OBJECTIVE:

THE PURPOSE OF THIS REPORT IS INTERPRETATION OF ENGINEERING PROPERTIES OF THE SOIL/ ROCK TO PROVIDE GEOTECHNICAL FEASIBILITY AND RECOMMENDATIONS REGARDING DESIGN OF FOUNDATION OF THE PROJECT.

1.7. SCHEDULE OF TESTING:

SEPT/OCT.-2017
1.8. **PURPOSES OF STUDY**

The overall purpose of these investigations was to present soil Stratigraphy of the proposed location and various strength parameters of soil samples recovered from the boring operations and thereby to develop geotechnical recommendation for foundation design and construction. To accomplish these purposes, the study was conducted as per the guidelines of **IS: 1892-1993** and in the following phases:

(a) **Making boreholes** through soil and up to refusal to determine site Stratigraphy and to collect disturbed and undisturbed soil samples for laboratory testing;

(b) **Testing** selected soil samples in the laboratory to determine pertinent index and engineering properties; and

(c) **Analyzing** all field and laboratory data to develop foundation design and construction recommendations

**1.9 PLANNING OF GEOTECHNICAL INVESTIGATION**

On the basis of nature of the project, it was decided to carry out soil exploration in order to:

(i) obtain soil samples, both representative and undisturbed (wherever necessary) for classification tests and other laboratory tests for determining engineering properties;

(ii) obtain soundings of penetration resistance by Standard Penetration test (as per IS:2131-1981) in the boreholes;
2. FIELD INVESTIGATION

2.1. **SOIL BORINGS**

The boreholes were progressed using a hand operated auger to the Specified depth or refusal, whichever is encountered earlier. The diameter of the borehole was 150 mm. Where caving of the borehole occurred, casing was used to keep the borehole stable. The work was in general accordance IS: 1892-1979.

Standard Penetration Test (SPT) was conducted in the borehole at 1.5 m interval by connecting a split spoon sampler to ‘A’ rods and driving it by 45 cm. The tests were conducted in accordance with IS: 2131-1981.

The numbers of blows for each 15 cm of penetration were recorded. The blows required to penetrate the initial 15 cm of the split spoon for seating the sampler is ignored due to the possible presence of loose materials or cuttings from the drilling operation. The cumulative number of blows required to penetrate the balance 30 cm of the 45 cm sampling interval is termed the SPT value of the ‘N’ value.

The ‘N’ values are presented on the profiles for each borehole. Refusal to further boring penetration was considered when the ‘N’ values exceed 50 or when practical refusal to further penetration by shell and auger was encountered.

Where the ‘N’ value exceeds 50, the penetration of split spoon sampler (after initial seating) is recorded together with the number of blows given of the sampler. Where the seating blow count exceeds 50, the ‘N’ value is recorded as “Ref” on the soil profile. **SPT ‘N’ values are correlated with relative density of non-cohesive stratum and with consistency of cohesive stratum:**

<table>
<thead>
<tr>
<th>Consistency</th>
<th>Penetration Value (blows)</th>
<th>Relative Density</th>
<th>Penetration Value (blows)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Soft</td>
<td>0-2</td>
<td>Very Loose</td>
<td>0-4</td>
</tr>
<tr>
<td>Soft</td>
<td>3-4</td>
<td>Loose</td>
<td>5-10</td>
</tr>
<tr>
<td>Medium Stiff</td>
<td>5-8</td>
<td>Medium</td>
<td>11-30</td>
</tr>
<tr>
<td>Stiff</td>
<td>9-16</td>
<td>Dense</td>
<td>31-50</td>
</tr>
<tr>
<td>Very stiff</td>
<td>17-32</td>
<td>Very Dense</td>
<td>&gt;50</td>
</tr>
<tr>
<td>Hard</td>
<td>&gt;32</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.2 DISTURBED SAMPLING (SOIL) IN BOREHOLES

Disturbed soil collected in the SPT sampler was preserved in polythene covers and transported to the laboratory. One more polythene cover was provided to prevent the loss of moisture during the transit period.

2.3 UNDISTURBED SAMPLING (SOIL) IN BOREHOLES

Undisturbed sampling is done in soft to stiff clayey soils. Undisturbed soil samples could not be collected in Very dense soil strata.

2.4 GROUNDWATER

Groundwater level was measured in the boreholes 24 hours after drilling and sampling was completed.
3. LABORATORY TESTS

The laboratory testing has been carried out at our laboratory at 40-P Tupudana Industrial Area, Tupudana Ranchi. The quality procedures in our laboratory conform to ISO/IEC-17025-2005.

The laboratory testing programme was aimed at verifying the field classifications and developing parameters for engineering analysis. All testing was performed in accordance with the current applicable IS specifications. The following tests were conducted on selected soil and water samples recovered from the borehole:

<table>
<thead>
<tr>
<th>Description of Test</th>
<th>IS : Code Referred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural moisture content</td>
<td>IS : 2720 (Part-2)-1973</td>
</tr>
<tr>
<td>Grain size analysis</td>
<td>IS : 2720 (Part-4)-1985</td>
</tr>
<tr>
<td>Liquid &amp; Plastic limit</td>
<td>IS : 2720 (Part-5)-1985</td>
</tr>
<tr>
<td>Specify Gravity</td>
<td>IS : 2720 (Part-3)-1980</td>
</tr>
<tr>
<td>Unconsolidated Undrained Triaxial shear test</td>
<td>IS : 2720 (Part-11)-1983</td>
</tr>
<tr>
<td>Chemical Analysis of soil/ water</td>
<td></td>
</tr>
<tr>
<td>Determination of pH value</td>
<td>IS : 2720 (Part-26)-1987</td>
</tr>
<tr>
<td>Determination of Sulphate content</td>
<td>IS : 2720 (Part-27)-1977</td>
</tr>
<tr>
<td>Determination Chloride content</td>
<td>IS : 3025 (Part-32)-1988</td>
</tr>
</tbody>
</table>

All test results are presented in the illustration section of this report.
FEW PICTURES SHOWING LABORATORY TESTING IN PROGRESS
4. FOUNDATION ANALYSIS

4.1 OPEN FOUNDATION

For satisfactory performance of a foundation, the following criteria must be satisfied;

(i) The foundation must not fail in shear.
(ii) The foundation must not settle by an amount more than the permissible settlement.

4.1.1 The allowable bearing capacity shall be taken as either of the following, whichever is less:

a) Net ultimate bearing capacity as obtained divided by suitable factor of safety, that is, net safe bearing capacity.

4.1.2 The net soil pressure that can be imposed on the base without the settlement exceeding the permissible values as given in IS : 1904-1978* to be determined for each structure and type of soil, that is, safe bearing pressure.

Types of soil formations are specified in IS : 1904-1978. The methods for calculations of settlements for assumed pressure from standard penetration resistance are specified in IS : 8009 (Part I)-1976; by calculating the settlements for two or three probable soil pressures and interpolating, the net soil pressure for permissible settlement may be estimated.
4.2 ALLOWABLE BEARING PRESSURE OF OPEN FOUNDATIONS
FROM SHEAR FAILURE METHOD AS PER IS:6403-1981 :

IS Code (IS:6403-1981), (Sec.5.1.2) recommends a bearing capacity equation which is similar in nature to those given by Meyerhoff and Brinch Hansen. The net ultimate bearing capacity of a shallow foundation of breadth \( B \) (m) is given as per the IS code by the equation:

\[
q_{nf} = cN_c \cdot s_c \cdot d_c \cdot i_c + q(N_q-1) \cdot s_q \cdot d_q \cdot i_q + 1/2.B.\gamma_N.\gamma_s.\gamma_d.\gamma_i.W'
\]

The net safe bearing capacity, \( q_{ns} \) = \( q_{nf} \) / factor of safety

Where
- \( c \) = cohesion (t/m\(^2\))
- \( q \) = effective surcharge at the base level of foundation (t/m\(^2\))
- \( \gamma_c \) = unit weight of subsoil (t/m\(^2\))
- \( B \) = breadth of footing
- \( L \) = length of footing
- \( \phi \) = angle of internal friction of soil
- \( D_f \) = depth of foundation
- \( N_c, N_q, N_\gamma \) = Bearing capacity factors given in relevant tables for general shear failure.
- \( \Phi' = \tan^{-1}(0.67 \phi) \) and corresponding values are taken for \( N_c, N_q, N_\gamma \).
- \( S_c, S_q, S_\gamma \) = shape factors
- \( d_c, d_q, d_\gamma \) = depth factors
- \( i_c, i_q, i_\gamma \) = inclination factors
- \( W' \) water table factor (=0.5 for water table at the footing level & 1.0 for water table at depth B below the footing, to be obtained by linear interpolation).

The values of the other factors are as tabulated below:

<table>
<thead>
<tr>
<th>Shape factor</th>
<th>Sq./circ.</th>
<th>Rect.</th>
<th>Strip</th>
<th>dc=1+0.2(Df/B)(N(\phi))0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>sc</td>
<td>1.3</td>
<td>1+0.2B/L</td>
<td>1.0</td>
<td>( dq=d_\gamma=1 ) for ( \phi&lt;10 )</td>
</tr>
<tr>
<td>sq</td>
<td>1.2</td>
<td>1+0.2B/L</td>
<td>1.0</td>
<td>( dq=d_\gamma=1+0.1(N(\phi))0.5 ) for ( \phi&gt;10 )</td>
</tr>
<tr>
<td>s(\gamma)</td>
<td>0.8/0.6</td>
<td>1-0.4B/L</td>
<td>1.0</td>
<td>( I_c=i_q=i_\gamma=1.0 ) for vertical loading</td>
</tr>
</tbody>
</table>

The net safe bearing capacity values calculated as above have to be checked for settlement in order to arrive at the net allowable bearing capacity values.
4.2.2 SAFE BEARING PRESSURE FROM SETTLEMENT CRITERIA
FROM SPT N VALUES:

The net soil pressure that can be imposed on the base without the settlement exceeding the permissible values as given in IS : 1904-1978* to be determined for each structure and type of soil, that is, safe bearing pressure.
Types of soil formations are specified in IS : 1904-1978. The methods for calculations of settlements for assumed pressure from standard penetration resistance are specified in IS : 8009 (Part I)-1976; by calculating the settlements for two or three probable soil pressures and interpolating, the net soil pressure for permissible settlement may be estimated.
5. GENERAL SITE CONDITIONS

5.1. GENERAL DESCRIPTION:

The boring has been done as per the approved layout plan. The sub-soil formation for the PRELIMINARY GEOTECHNICAL INVESTIGATION FOR AFFORDABLE HOUSING PROJECT UNDER PMAY AT SERAIKELA, JHARKHAND (SITE: NORODIH, WARD NO: 02, THANNA NO: 292, ANCHAL: SERAIKELA, KHATA NO: 18, PLOT NO: 801) has been investigated by sinking 1 no. of borehole explored up to a depth of refusal strata.

5.2. GENERAL GEOLOGY:

The Major landforms of the area are granite gneiss. Undulating erosional surface with interrupting dykes, ridges and inselbergs are prominent features. Valley fills- These are developed over granite gneiss. It consists of boulders, cobbles, pebbles, gravels, sandy silt and clays.

There are three well-defined seasons in region. The cold-weather season, from November to February, is the most pleasant part of the year. Lowest temperature in Jharkhand lies between -5°C to 0°C. High temperatures in December usually rise from about 50 °F (10 °C) into the low 70s F (low 20s C) daily. The hot-weather season lasts from March to mid-June. May, the hottest month, is characterized by daily high temperatures in the upper 90s F (about 37 °C) and low temperatures in the mid-70s F (mid-20s C). Maximum rainfall takes place during the months from July to September that accounts for more than 90% of total rainfall in the state.
5.3. SUB-SURFACE CONDITIONS:
The field investigation data and the results of laboratory tests conducted on the samples collected from the bore holes in general reveal similar stratification.
⇒ The detailed soil profile and various soil layers have been provided in the soil profile attached.
⇒ The soil strata is medium-plastic silty gravelly clayey strata and non-plastic sandy silt/weathered rocks up to the depth explored.
⇒ The Bore logs in the annexure present the detailed Stratigraphy, cross sections and nature of soil at the borehole locations.

5.4. GROUND WATER CONDITIONS:

During the current subsurface exploration ground water was not found during exploration in the site. It should be noted that these observations reflect groundwater levels at the time of the field investigation and actual groundwater levels may fluctuate significantly in response to seasonal effects, regional rainfall, and other factors not observed during this investigation. There may be regional or perched water tables at greater depth. However for the design purposes the ground water level has been considered at footing level as the ground water level may rise in peak rainy season due to unforeseen reasons.
5.5. REGIONAL SEISMICITY:

The intensity of an earthquake at a place is a measure of the strength of shaking during the earthquake, and is indicated by a number according to the modified Mercalli Scale or M.S.K. Scale of seismic intensities.

The Zone factors ‘Z’ for various Seismic zones as per IS:1893 (P-1)-2002 is as follows:

<table>
<thead>
<tr>
<th>Seismic Zone</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic Intensity</td>
<td>LOW</td>
<td>MODERATE</td>
<td>SEVERE</td>
<td>VERY SEVERE</td>
</tr>
<tr>
<td>Z</td>
<td>0.10</td>
<td>0.16</td>
<td>0.24</td>
<td>0.36</td>
</tr>
</tbody>
</table>

The area falls under Zone-II as classified by Bureau of Indian Standards, indicating low active zone.

5.6. LIQUEFACTION:

Liquefaction is a state in saturated cohesionless soil wherein the effective shear strength is reduced to negligible value for all engineering purpose due to pore pressure caused by vibrations during an earthquake when they approach the total confining pressure. In this condition the soil tends to behave like a fluid mass.

Typically, cyclic loading of saturated soils leads to the buildup of excess pore-water pressure as a result of soil particles being rearranged with a tendency toward denser packing. Under undrained conditions (such as during earthquake shaking), loads are transferred from the soil skeleton to the pore-water with consequent reduction in the soils' shear strength.

Liquefaction-induced ground settlement and lateral spreading have been the primary cause for extensive damage to aboveground structures, foundations and pipelines during many earthquakes.

5.7. LIQUEFACTION ASSESSMENT

Subsurface consists of silty sand with high standard penetration resistance, followed by dense rocky strata, hence site may be classified as “Liquefaction unlikely” in earthquake event.
6. CONCLUSIONS AND RECOMMENDATIONS

The foundation shall be designed to withstand the worst combinations of loads and forces. The foundation depth shall also be sufficient from consideration of bearing capacity, settlement, liquefaction potential, stability and suitability of strata at the founding level and sufficient depth below it.

Considering the soil strata encountered shallow open foundation is recommended for the foundations.

6.1 SHALLOW FOUNDATIONS

Bearing capacity analysis for open foundations bearing on soils at site has been done in accordance with IS: 6403-1981 & IS 8009 (Part-1) 1976 based on laboratory and field tests.

RECOMMENDED NET ALLOWABLE BEARING PRESSURE HAS BEEN PROVIDED FOR BUILDING:

AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT SERAIKELA, JHARKHAND (SITE: NORODIH, WARD NO:02, THANA NO: 292, ANchal : SERAIKELA, KHATA NO: 18, PLOT NO:801)

Notes:
⇒ It has been found that the water table will rise to 1.50 from EGL during the peak rainy season.
⇒ A maximum settlement of 40mm is expected.
⇒ The depth of embedment of foundation has been given from the existing ground level any cutting or filling at that point should be adequately taken care of.
⇒ The detailed calculations have been annexed with this report.
⇒ Detailed geotechnical investigation is recommended at the actual building location prior to construction work.
<table>
<thead>
<tr>
<th>LOCATION</th>
<th>DEPTH OF FOUNDATION (m)</th>
<th>TYPE OF FOUNDATION</th>
<th>RL OF BORE HOLE TOP (m)</th>
<th>RL OF FOUNDATION LEVEL (m)</th>
<th>RECOMMENDED NET ALLOWABLE BEARING PRESSURE (kN/m²)</th>
<th>FOUNDING STRATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRELIMINARY GEOTECHNICAL INVESTIGATION FOR AFFORDABLE HOUSING PROJECT UNDER PMAY AT SERAIKELA, JHARKHAND (SITE: NORODIH, WARD NO: 02, THANA NO: 292, ANCHAL: SERAIKELA, KHATA NO: 18, PLOT NO: 801)</td>
<td>1.50</td>
<td>OPEN/ ISOLATED</td>
<td>100.00</td>
<td>98.50</td>
<td>160.00</td>
<td>SANDY SILT/ WEATHERED ROCKS</td>
</tr>
<tr>
<td></td>
<td>1.80</td>
<td>OPEN/ ISOLATED</td>
<td>100.00</td>
<td>98.20</td>
<td>190.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>OPEN/ ISOLATED</td>
<td>100.00</td>
<td>98.00</td>
<td>210.00</td>
<td></td>
</tr>
</tbody>
</table>

MAXIMUM PERMISSIBLE SETTLEMENT: 40mm
6.2 CONSTRUCTION CONSIDERATIONS

6.2.1 Site Work Preparation:

Prior to construction of any new foundations, all areas that will receive fill, base rock, or structures should be stripped of all surface vegetation, organic topsoil, and any deleterious materials that might be encountered. Any soft or unsuitable soils encountered during stripping or excavation should be removed and replaced with structural fill meeting the requirements.

6.2.2 Shallow Foundation Excavation:

We recommend that excavations for foundations in soil and weathered rock be accomplished with a straight-edged grading bucket to minimize disturbance of the bearing surfaces. Following excavation, the bearing surfaces should be thoroughly cleaned of loosened or disturbed soil, by hand if necessary. Any soft or unsuitable soils encountered at the base of foundation excavation should be removed and replaced with compacted structural fill.

The temporary excavation is expected to be through the Silty gravelly clayey soil.

<table>
<thead>
<tr>
<th>DESCRIPTION OF STRATA</th>
<th>RECOMMENDED SIDE SLOPES</th>
<th>EXCAVATION METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILTY GRAVELLY CLAY</td>
<td>1V:2H</td>
<td>Conventional Excavators</td>
</tr>
</tbody>
</table>

6.2.3 Cement:

Chemical analyses of sub-soil water and soil samples were carried out and pH, Chloride and Sulphate values were calculated. The result of chemical analysis of subsoil sample indicate that the pH value, sulphate content, chloride content are within permissible limit and the RCC work prepared with Ordinary Portland Cement shall not be deteriorated when placed over/within site subsoil.
7. LIMITATIONS

This report presents recommendations pertaining to the proposed structures as represented to Sun-Tech, as described herein. The findings and recommendations presented in this report are based upon soil conditions observed the available subsurface explorations, interpolation of the soil conditions between test pits, and extrapolation of these conditions throughout the proposed site area. They are further based on the assumption that the subsurface conditions do not deviate appreciably from those reported and those assumed. However, the possibility of different conditions cannot be discounted. In the event that changes in design loads or structural characteristics described in this report are made, Sun-Tech should be retained to review our design recommendations and their applicability to the revised design plans. In this way, any required supplemental recommendations can be made in a timely manner.

This report has been prepared for the specific project, purpose, and customer stated in the report; the report may not be adequate for other uses. The use of the recommendations of this report for other projects or purposes or by other parties is not authorized.

Although Sun-Tech has endeavored to characterize the surface and subsurface conditions at the site, Sun-Tech is not as able to assess potential construction difficulties as is a contractor specializing in the work to be performed. Consequently, the Contractor is responsible, and Sun-Tech is not, for final evaluation of potential construction difficulties.

This report has been prepared in accordance with the care and skill generally exercised at the present time by reputable professionals in the field of geotechnical engineering, under similar circumstances, for projects in the project locality. No other warranty, either expressed or implied, is made as to the professional advice presented herein.

For Sun-Tech, Ranchi

(Pranay Kumar)
8. LIST OF APPENDICES

8.1 Bore Hole Location

8.2 Field Bore Log Data Sheet

8.3 Calculations

8.4 Laboratory Test Results
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SYMBOL</th>
<th>GRAPHIC LOG</th>
<th>DEPTH</th>
<th>Standard Penetration Test</th>
<th>SAMPLE/TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stiff medium-plasticity, inorganic, yellowish silty gravelly clayey soil.</td>
<td>CI</td>
<td></td>
<td>0.0</td>
<td>05 07 08 15</td>
<td></td>
</tr>
<tr>
<td>Very dense yellowish non-plastic sandy slil, inorganic soil / weathered</td>
<td>SM</td>
<td></td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very dense weathered rock strata.</td>
<td></td>
<td></td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refusal: N=100 for penetration of 10 cm</td>
<td></td>
<td></td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Termination
## SUMMARY OF CALCULATIONS

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>RL (m) OF BORE HOLE TOP</th>
<th>DEPTH (m)</th>
<th>RL (m) OF FOUNDATION LEVEL</th>
<th>SIZE OF FOUNDATION (m)</th>
<th>SHEAR CRITERIA</th>
<th>SETTLEMENT CRITERIA</th>
<th>RECOMMENDED NET ALLOWABLE BEARING PRESSURE (ton/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TYPE OF SHEAR FAILURE</td>
<td>C kg/cm²</td>
<td>°</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GENERAL</td>
<td>0.00</td>
<td>28.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GENERAL</td>
<td>0.00</td>
<td>28.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GENERAL</td>
<td>0.00</td>
<td>28.00</td>
</tr>
</tbody>
</table>
### SHEAR ANALYSIS AS PER IS: 6403-1981

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Depth (m)</th>
<th>Width (m)</th>
<th>Length (m)</th>
<th>Cohesion c (kg/cm²)</th>
<th>Angle of Repose (Degree)</th>
<th>Sc</th>
<th>Sq</th>
<th>Sy</th>
<th>Bulk Density g/cc</th>
<th>Bearing Capacity Factors</th>
<th>Water Table correction</th>
<th>Ultimate Bearing Capacity t/m²</th>
<th>Net safe Bearing Capacity t/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seraikea, Jharkhand</td>
<td>1.50</td>
<td>3.00</td>
<td>3.00</td>
<td>0.00</td>
<td>28.00</td>
<td>1.30</td>
<td>1.20</td>
<td>0.80</td>
<td>2.05</td>
<td>25.80</td>
<td>14.72</td>
<td>16.72</td>
<td>0.50</td>
</tr>
<tr>
<td>Seraikea, Jharkhand</td>
<td>1.80</td>
<td>3.00</td>
<td>3.00</td>
<td>0.00</td>
<td>28.00</td>
<td>1.30</td>
<td>1.20</td>
<td>0.80</td>
<td>2.05</td>
<td>25.80</td>
<td>14.72</td>
<td>16.72</td>
<td>0.50</td>
</tr>
<tr>
<td>Seraikea, Jharkhand</td>
<td>2.00</td>
<td>3.00</td>
<td>3.00</td>
<td>0.00</td>
<td>28.00</td>
<td>1.30</td>
<td>1.20</td>
<td>0.80</td>
<td>2.05</td>
<td>25.80</td>
<td>14.72</td>
<td>16.72</td>
<td>0.50</td>
</tr>
</tbody>
</table>

ASSUMPTIONS: ASSUMING GENERAL SHEAR FAILURE CONDITIONS AS PER IS: 6403-1981. FACTOR OF SAFETY: 3.00 DEPTH FACTOR TAKEN AS 1.00
## SETTLEMENT ANALYSIS FOR SHALLOW FOUNDATIONS BASED ON SPT N VALUES IS:8009 (Part-1)-1976, Cl. 9.1.4

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Depth of Foundation (m)</th>
<th>SIZE OF FOUNDATION</th>
<th>SPT Design Value</th>
<th>Water table correction Rw</th>
<th>Settlement @ 1.00kg/cm² (as read from graph) mm</th>
<th>Fox’s Depth Factor</th>
<th>Rigidity Factor dr</th>
<th>NET ALLOWABLE BEARING PRESSURE (q&lt;sub&gt;a40&lt;/sub&gt;) FOR A SETTLEMENT OF 40 mm IN ton/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B (m)</td>
<td>L(m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preliminary Geotechnical Investigation for Affordable Housing Project Under PMAY at Seraikela, Jharkhand (Site: Norodih, Ward No:02, Thana No : 292, Anchal: Seraikela, Khata No : 18, Plot No:801)</td>
<td>1.50</td>
<td>3.00</td>
<td>3.00</td>
<td>21.00</td>
<td>0.50</td>
<td>15.20</td>
<td>0.80</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>1.80</td>
<td>3.00</td>
<td>3.00</td>
<td>23.00</td>
<td>0.50</td>
<td>13.60</td>
<td>0.78</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>3.00</td>
<td>3.00</td>
<td>25.00</td>
<td>0.50</td>
<td>12.00</td>
<td>0.78</td>
<td>1.00</td>
</tr>
</tbody>
</table>

- **Design Water Depth**: Ground level
- **Rw factor considering worst condition**: 0.500
- **Fox’s Depth Factor to be considered**: yes
- **Depth to be ignored in Depth Factor Computation for loose soil**: yes
- **Tolerable settlement (mm)**: 40.00
## LABORATORY TEST RESULTS ON SOIL SAMPLES

<table>
<thead>
<tr>
<th>BH No.</th>
<th>Sample Type</th>
<th>Sample Number</th>
<th>Depth (m)</th>
<th>Grain Size Distribution</th>
<th>Shear Strength test</th>
<th>Chemical Test</th>
<th>Consolidation Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-1</td>
<td>U</td>
<td>17230</td>
<td>1.50</td>
<td>gravel %: 0.29, sand %: 72.11, silt %: 27.60, clay %: 0.00</td>
<td>-</td>
<td>SM 9.82</td>
<td>2.05</td>
</tr>
</tbody>
</table>

### Notes:
- **Project Code**: S1011017
- **Consultants**: REI INFRASTRUCTURE FINANCE LTD. 'VISHWAKARMA' 86, CTOPIA ROAD (SOUTH,) KOLKATA-700046
- **Client**: JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT COMPANY LTD.
- **Project**: PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PREPARATION OF DETAILED PROJECT REPORT ON AFFORDABLE HOUSING PROJECT UNDER PRADHAN MANTRI AWAS YOJANA AT SERAIKELA, JHARKHAND
- **Site**: NORODIH, WARD NO:02, THANA NO : 292, ANCHAL : SERAIKELA, KHATA NO : 18, PLOT NO:801

### Abbreviation used:
- UUT: Triaxial Unconsolidated Undrained
- TCU: Triaxial Consolidated Undrained
- TCD: Triaxial Consolidated Drained
- DS: Direct Shear
- UC: Unconfined Compressive

### Limitations:
- pH: 6.5-8.5
- Chloride: 2000mg/l max.
- Sulfate: 400mg/l max.
- ND: NOT DETECTED

### Sampling Process:
- Samples from Bore holes

### Authorised Signatory:
(Pranay Kumar)