



VII-7

Annexes

List of Annexes

Annex No.	Description
Annex A	Line route layout drawing
Annex A-1	List of preliminary route angle point coordinates
Annex A-2	Lekhnath Substation Layout
Annex B + C	Typical tower outlines
Annex D	Typical arrangement of towers
Annex E	Typical foundations
Annex F, G, H + I	Insulator sets
Annex J	Typical Earthing System
Annex K + L	EW Attachment Sets
Annex M, N + O	OPGW Attachment Sets
Annex P	OHL/SS limit of scope of supply
Annex Q	Preliminary Geotechnical Investigation elaborated for Bidding Purpose



Annex A-1

List of preliminary route angle
point coordinates

**Lekhnath - Damauli 220 kV
 Transmisison Line Project
 Preliminary angle point coordinates**

rev. 3 06/2022

Issued for Tender

220 kV Lekhnath-Damauli

Angle Point label	UTM Coordinates Grid Zone 45N - WGS 1984	
	Easting (m)	Northing (m)
AP 1	211057	3120701
AP 2	211375	3120847
AP 3	211446	3120845
AP 4	211590	3120849
AP 5	212035	3121181
AP 6	212543	3121126
AP 7	212882	3121327
AP 8	213083	3121413
AP 9	213699	3122049
AP 10	215167	3122297
AP 11	215437	3122142
AP 12	215611	3122070
AP 13	216021	3121965
AP 14	216413	3121840
AP 15	216594	3121877
AP 16	216901	3121781
AP 17	217582	3121272
AP 18	218670	3120897
AP 19	220217	3119904
AP 20	220539	3119741
AP 21	221326	3119262
AP 22	221561	3119021
AP 23	221844	3118694
AP 24	221913	3118377
AP 25	222344	3117110
AP 26	223085	3116574
AP 27	223637	3116318
AP 28	224165	3116336
AP 29	224779	3116206
AP 30	224993	3115971
AP 31	225195	3115675
AP 32	225225	3115583

**Lekhnath - Damauli 220 kV
 Transmisison Line Project
 Preliminary angle point coordinates**

rev. 3 06/2022

Issued for Tender

220 kV Lekhnath-Damauli

Angle Point label	UTM Coordinates Grid Zone 45N - WGS 1984	
	Easting (m)	Northing (m)
AP 33	225362	3115114
AP 34	225552	3114889
AP 35	225530	3114275
AP 36	225642	3113989
AP 37	225800	3113726
AP 38	226047	3112185
AP 39	226278	3111818
AP 40	226440	3111151
AP 41	227001	3109801
AP 42	227748	3109160
AP 43	227907	3108727
AP 44	228141	3108257
AP 45	228147	3108055
AP 46	227959	3107661
AP 47	227988	3107148
AP 48	227629	3106645
AP 49	227513	3106455
AP 50	227678	3105832
AP 51	227731	3105489
AP 52	227745	3105209
AP 53	227731	3105008
AP 54	227751	3104539
AP 55	227386	3104227
AP 56	226947	3103699
AP 57	226779	3103289
AP 58	226355	3102757
AP 59	226433	3101464
AP 60	228197	3099714
AP 61	228691	3098514

**Lekhnath - Damauli 220 kV
 Transmisison Line Project
 Preliminary angle point coordinates**

rev. 3 06/2022

Issued for Tender

220 kV Lekhnath-Damauli

Angle Point label	UTM Coordinates Grid Zone 45N - WGS 1984	
	Easting (m)	Northing (m)
AP 62	228606	3098172
AP 63	228581	3097843
AP 64	229737	3096997
AP 65	230456	3095867
AP 66	231203	3095867
AP 67	231386	3095675
AP 68	231986	3094953
AP 69	232336	3094977
AP 70	232794	3095107
AP 71	233003	3095288
AP 72	233139	3095465
AP 73	233370	3095570
AP 74	233506	3095875
AP 75	233649	3096021
AP 76	233672	3096266
AP 77-L	233601	3096471
AP 77-T	233645	3096418
AP 77-B	233668	3096461

Preliminary angle point coordinates were measured from satellite imagery and partly revised through site visit.

These coordinates have an accuracy of +/- 10 meters.

Coordinate System UTM, Datum: WGS84, Grid Zone 45 North.

**Lekhnath - Damauli 220 kV
 Transmisison Line Project
 Preliminary angle point coordinates**

rev. 3 06/2022

Issued for Tender

220 kV Tanahu Hydro LI-LO

Angle Point label		UTM Coordinates Grid Zone 45N - WGS 1984	
		Easting (m)	Northing (m)
AP TB1		232212	3094317
AP TB2		232380	3094513
AP TB3		232599	3094852

132 kV Damauli-Bharatpur LI-LO

Angle Point label		UTM Coordinates Grid Zone 45N - WGS 1984	
		Easting (m)	Northing (m)
AP DB1		233668	3097019
AP DB2		233668	3096989
AP DB3		233715	3096637
AP DB4		233706	3096597

132 kV OHL Tower Inside Lekhnath Substation

Angle Point label		UTM Coordinates Grid Zone 45N - WGS 1984	
		Easting (m)	Northing (m)
AP LK1		210927	3120638

Preliminary angle point coordinates were measured from satellite imagery and partly revised through site visit.

These coordinates have an accuracy of +/- 10 meters.

Coordinate System UTM, Datum: WGS84, Grid Zone 45 North.



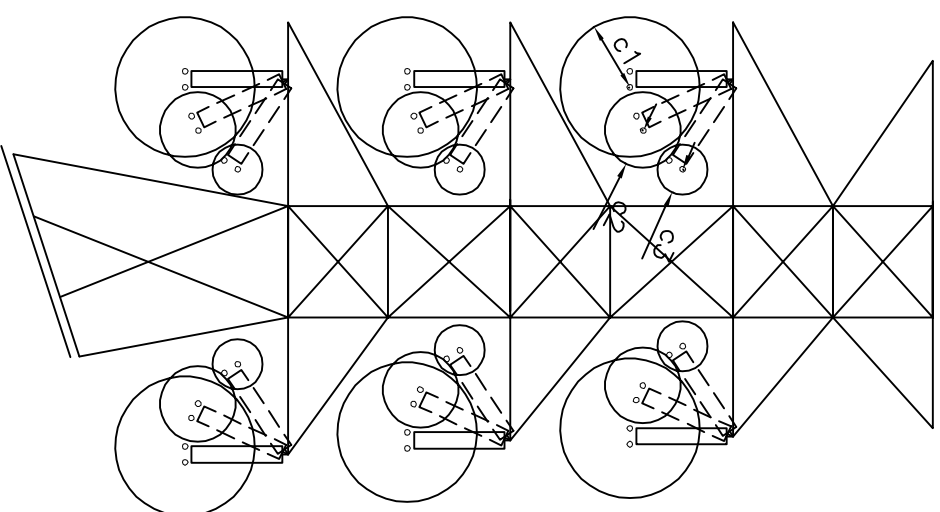
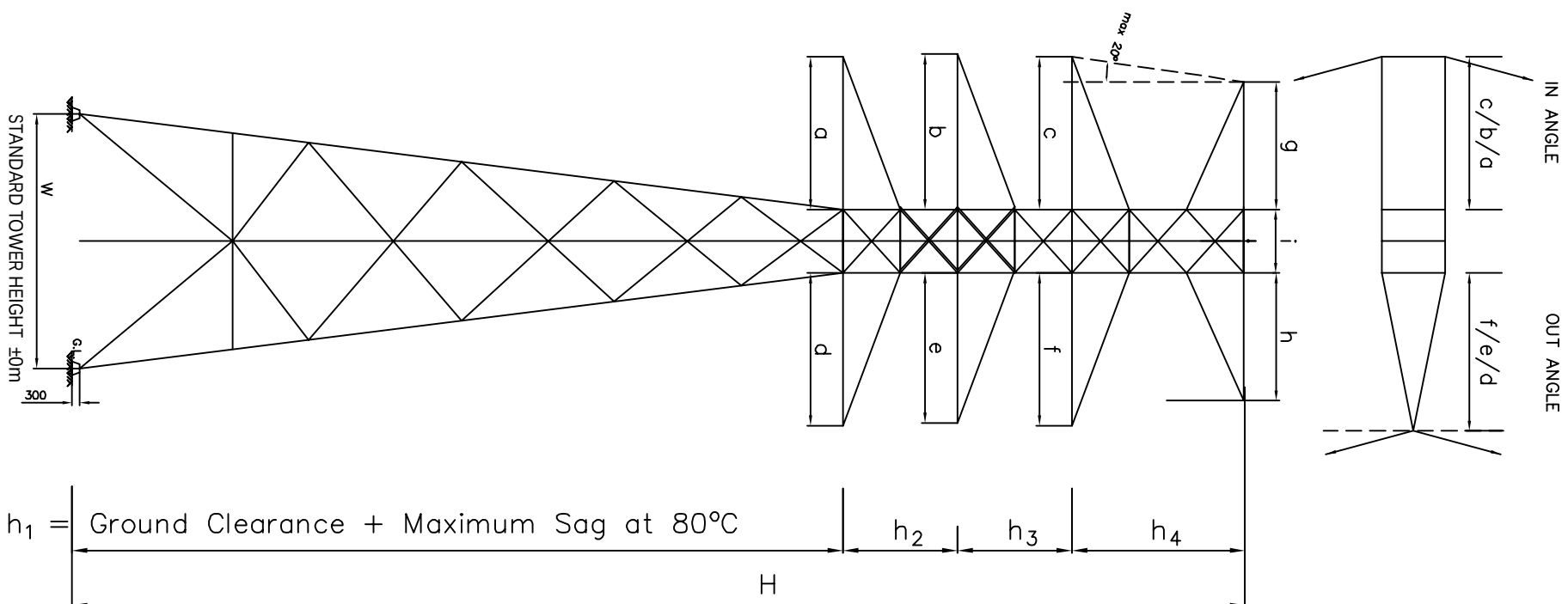
Annex A-2

Lekhnath Substation Layout



Annex B

Typical tower outlines



Tower Types	
DA	- normal suspension tower, applicable for line deviation angles $\alpha = 0^\circ - 2^\circ$
DB	- light angle / section tension tower, applicable for line deviation angles $\alpha = 0^\circ - 15^\circ$
DC	- medium angle / section tension tower, applicable for line deviation angles $\alpha = 15^\circ - 30^\circ$
DD	- heavy angle tension tower, applicable for line deviation angles $\alpha = 30^\circ - 60^\circ$
DE	- dead-end tower, suitable for 0 to 45° angle in line direction and 0° to 45° angle of the slack span to the gantry.

TOWER GEOMETRY (meters)

Height

- | | |
|----|---|
| h4 | - between bottom crossarm to ground (Standard Tower Height ±0m) |
| h3 | - between bottom crossarm to middle crossarm |
| h2 | - between middle crossarm to upper crossarm |
| h1 | - between upper crossarm to earthwire peak |
| H | -Total height of Standard Tower ±0m |

Left (in angle) crossarms lengths

- a - bottom crossarm
- b - middle crossarm
- c - upper crossarm

Right (out angle) crossarms lengths

- d - bottom crossarm
e - middle crossarm
f - upper crossarm
w - Width at base for Standard Tower ± 0 m

Electrical Clearances D_{el} (Live to Earthed Parts)

- c1 - Still air
c2 - Moderate Wind
c3 - Maximum Wind

NOTES:

- 1 - Tower layout is informative only. The Bidder shall propose the most economical shape of the structure
- 2 - For DC, DD and DE angle towers, the "in angle" crossarms shall be equipped with Jumper Suspension Strings
- 3 - For typical tower body and leg extensions arrangement, refer to drawing ---
- 4 - Design spans shall be according to Data Sheets
- 5 - Electrical Clearances shall be according to Data Sheets
- 6 - Phase Conductor : 2 x ACSR MOOSE per phase
- 7 - Earthwires : 1 x ACS 95 mm² + 1 x OPGW equivalent to ACS 95 mm²

3				
2				
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0	11/2021	NICULAE	-	
	Date	Originator	Approver	Change notes

		 NEPAL ELECTRICITY AUTHORITY नेपाल विद्युत प्राधिकरण	
Project No.	4899A81	Consulting Services for Lekhnath–Damauli 220 kV Transmission Line Project Typical Double Circuit Tower Layout	
Date:	11/2021		
System:	AUTOCAD		
Scale	—		
Sheet:	1 / 1	Format: A3	Dwg–Nr.: —

Drawing for Tender purpose
All dimensions are indicative only

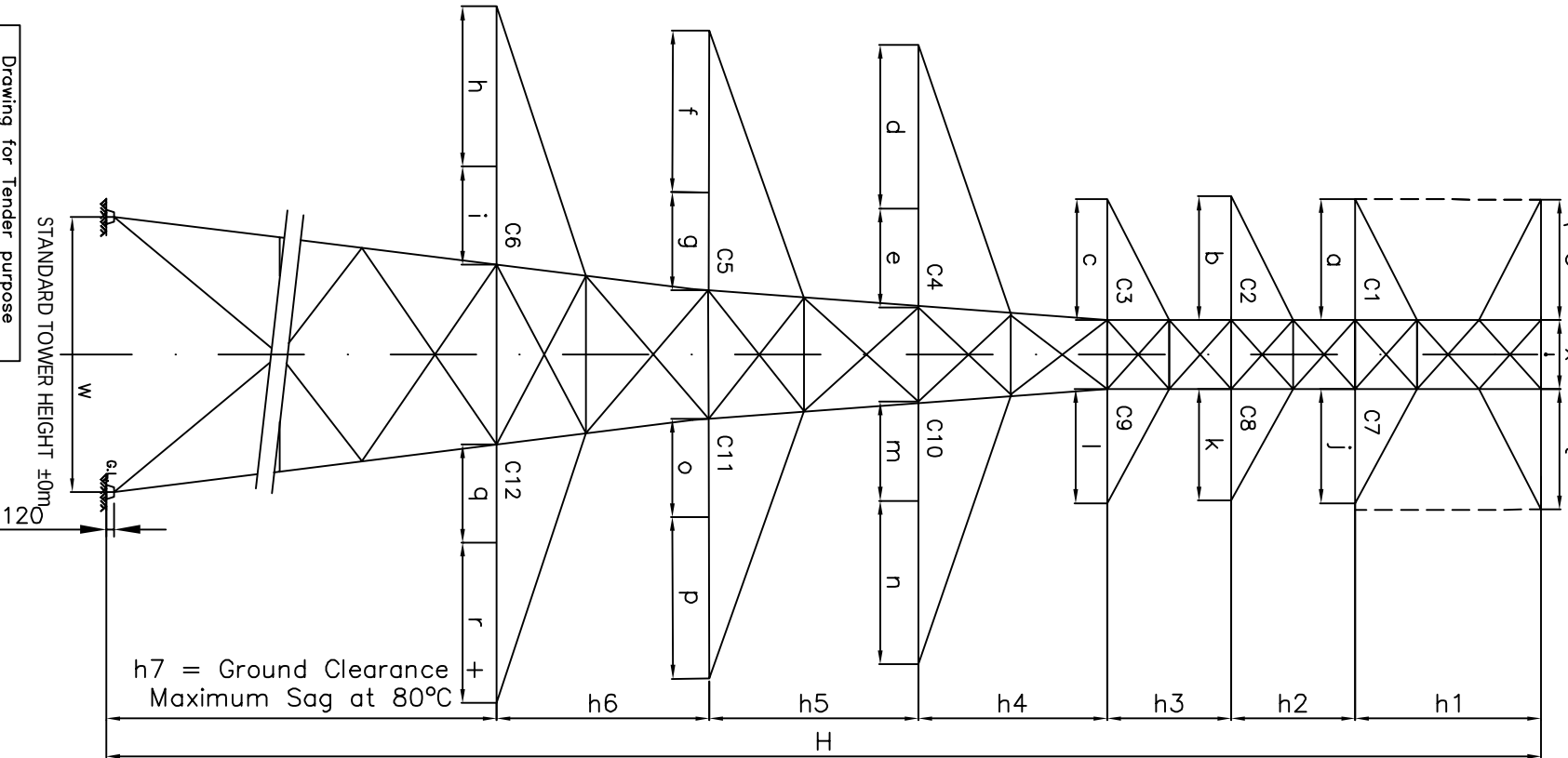
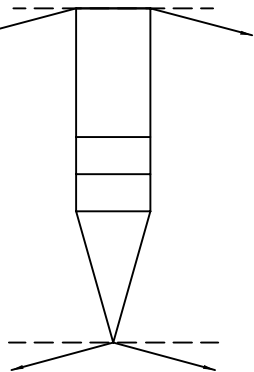
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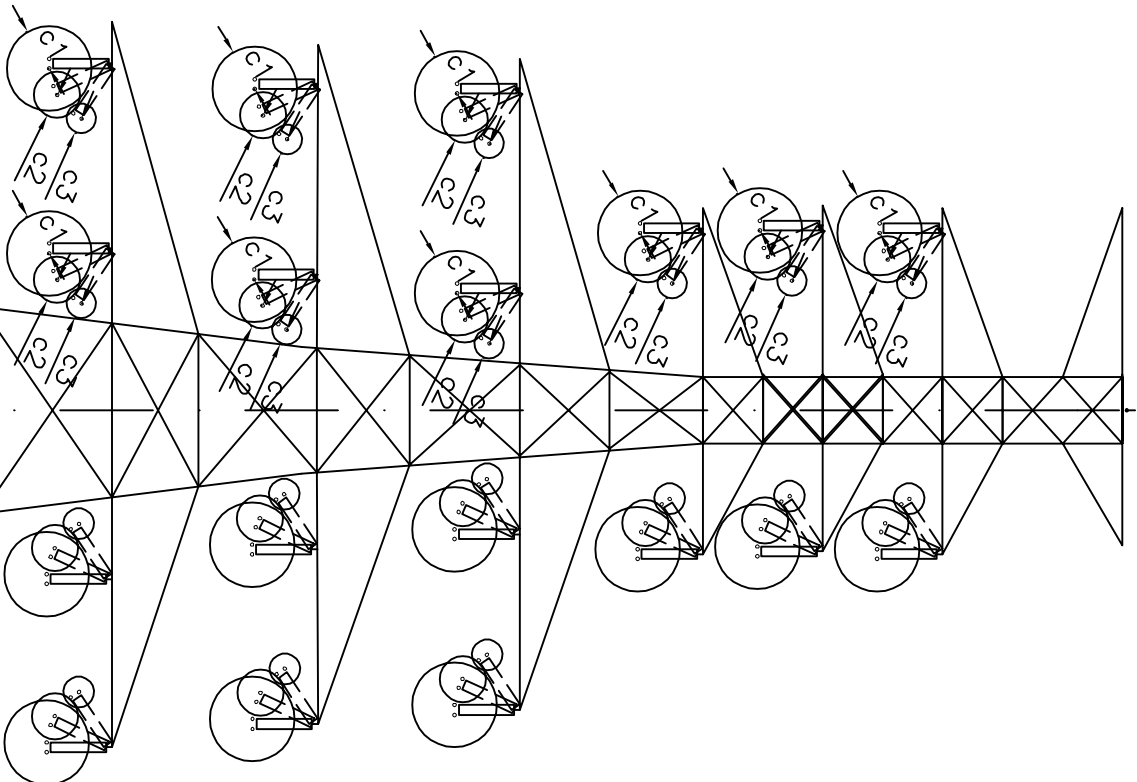
Annex C

Typical tower outlines

IN ANGLE OUT ANGLE



Drawing for Tender purpose
All dimensions are indicative only



Tower Types

6T - six circuit tower, applicable for line deviation angles $\alpha = 0^\circ - 50^\circ$

TOWER GEOMETRY (meters)

Height

- h7 - between bottom crossarm to ground (Standard Tower Height $\pm 0m$)
- h5, h6 - between crossarms corresponding to bottom circuits
- h4 - between crossarms corresponding to upper and bottom circuits
- h2, h3 - between crossarms corresponding to upper circuits
- h1 - between upper crossarms and earthwire peak
- H - Total height of Standard Tower $\pm 0m$

Left (in angle) crossarms lengths

- a - C1 crossarm
- b - C2 crossarm
- c - C3 crossarm
- d, e - C4 crossarm (outer and inner circuits)
- f, g - C5 crossarm (outer and inner circuits)
- h, i - C6 crossarm (outer and inner circuits)

Right (out angle) crossarms lengths

- j - C7 crossarm
- k - C8 crossarm
- l - C9 crossarm
- m, n - C10 crossarm (outer and inner circuits)
- o, p - C11 crossarm (outer and inner circuits)
- q, r - C12 crossarm (outer and inner circuits)

- s - Left (in angle) earthpeak length
- t - Right (out angle) earthpeak length
- x - Width at top
- w - Width at base for Standard Tower $\pm 0m$

Electrical Clearances D_{el} (Live to Earthed Parts)

- c1 - Still air
- c2 - Moderate Wind
- c3 - Maximum Wind

NOTES:

- 1 - Tower layout is informative only. The Bidder shall propose the most economical shape of the structure
- 2 - "In angle" crossarms shall be equipped with Jumper Suspension Strings where required
- 3 - Design spans shall be according to Data Sheets
- 4 - Electrical Clearances shall be according to Data Sheets
- 5 - Phase Conductor : 2 x ACSR MOOSE per phase
- 6 - 2 x OPGW equivalent to ACS 95 mm²

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Date	Originator	Approver	Change notes

FICHTNER



Project No.	4899A81	Consulting Services for Lekhnath–Damauli 220 kV
Date:	11/2021	Transmission Line Project
System:	AUTOCAD	Typical Six Circuit Tower Layout
Scale	—	
Sheet:	1 / 1	Format: A3 Dwg–Nr.: —



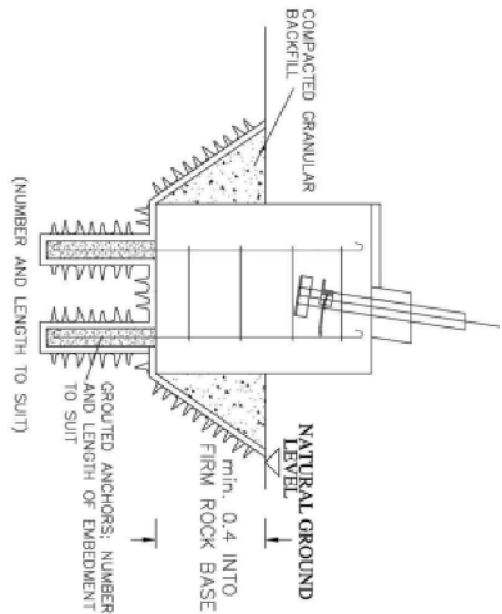
Annex D

Typical arrangement of towers

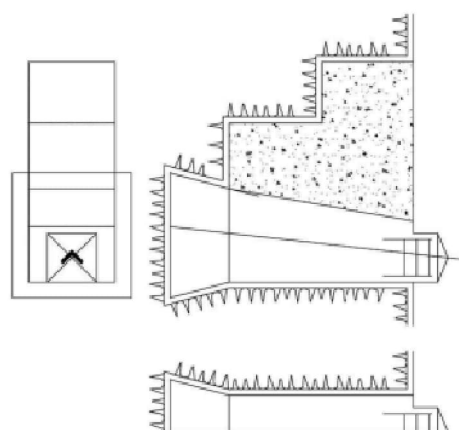


Annex E

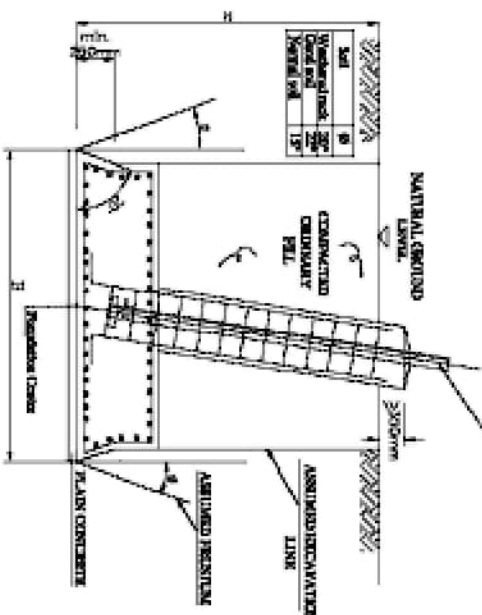
Typical foundations



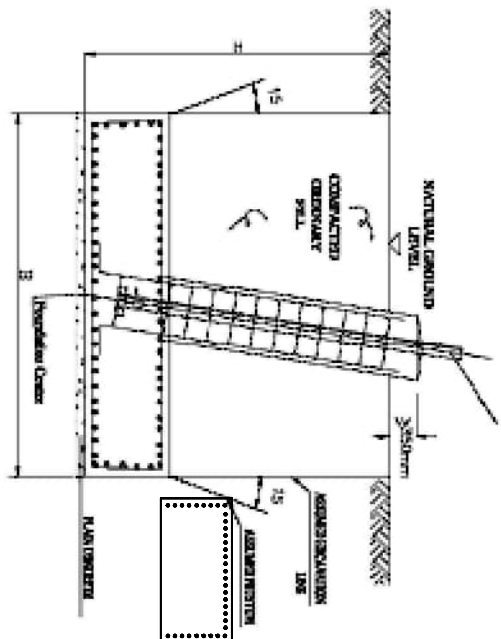
Soil Type1 : Sound rock
Foundation type : Rock Anchor



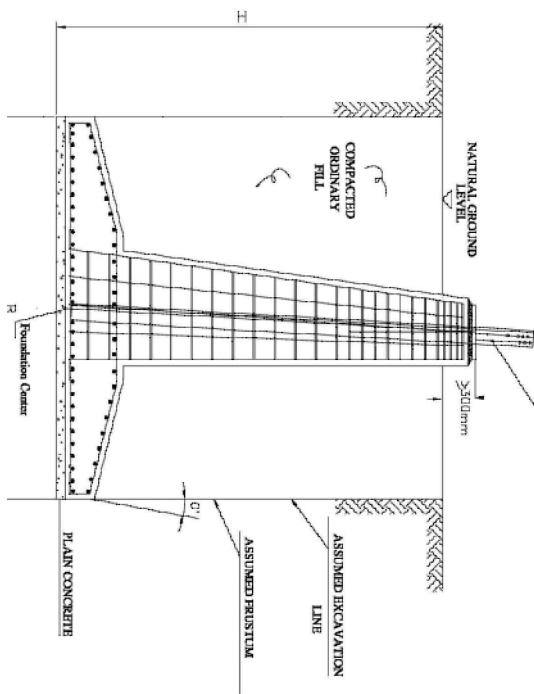
Soil Type1,2 : Sound rock, Fissured rock
Foundation type : Concrete Block/Shaft



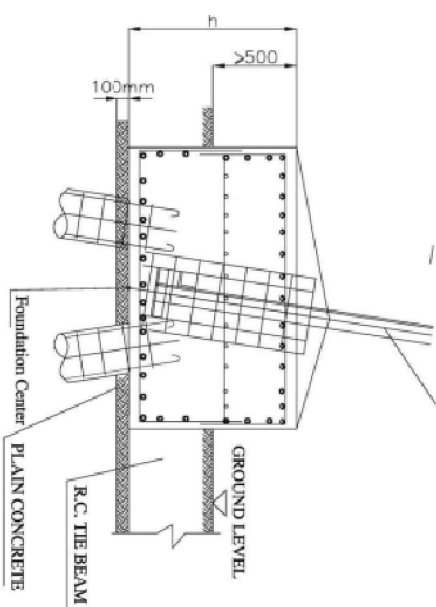
Soil Type 2,3,4 : Fissured rock, normal soil, sandy soil
Foundation type : Pad & Chimney with undercut



Soil Type 2,3,4 Fissured rock, normal soil, sandy soil
Foundation type: Pad & Chimney without undercut



Soil Type 2,3,4 Fissured rock, normal soil, sandy soil
Foundation type: Pyramid & Chimney



Soil Type 3 Wet black cotton (>3.5m)
Foundation type : Piles

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Date	Originator	Approver	Change notes

FICHTNER



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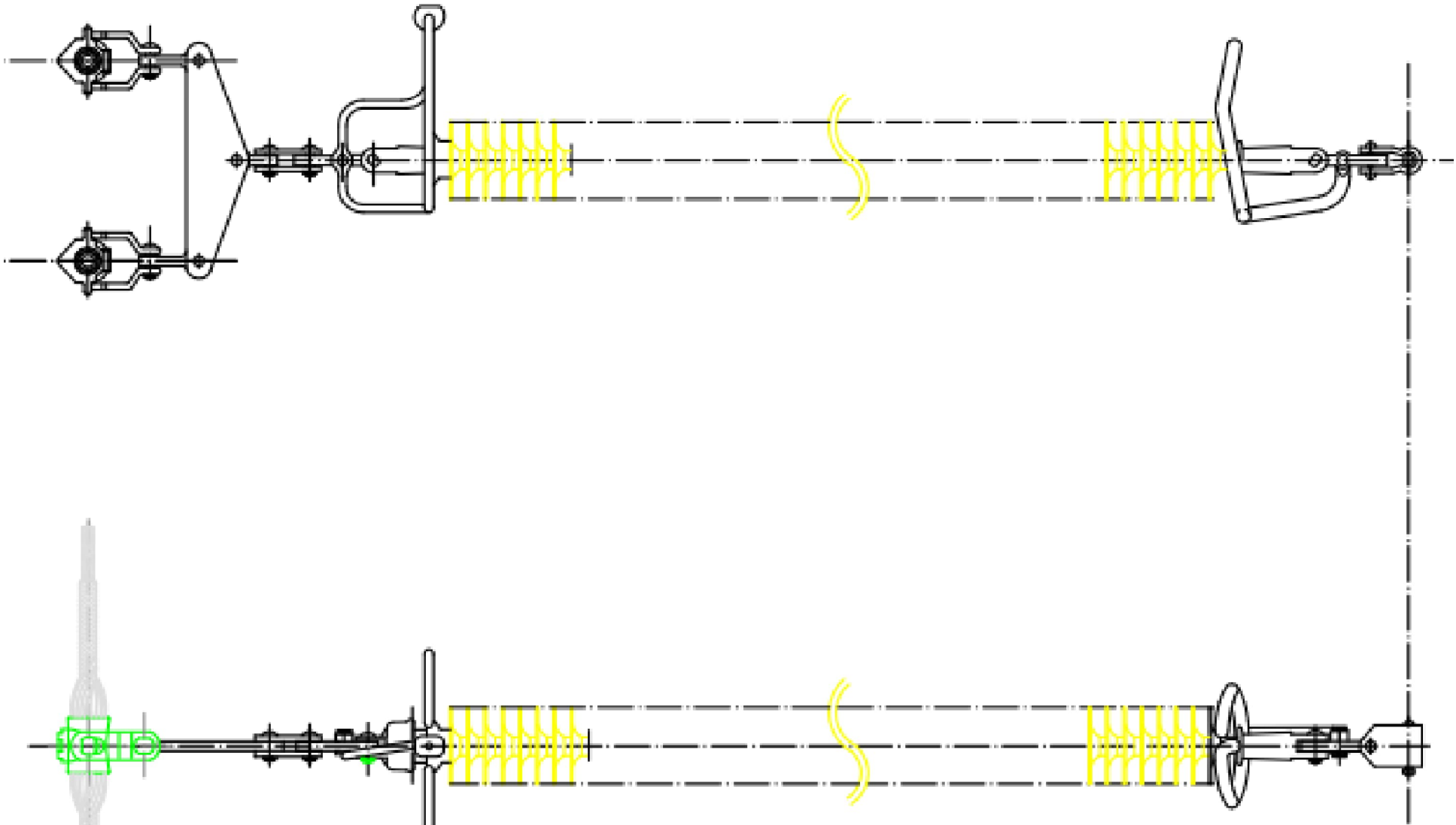
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Date:	11/2021	Transmission Line Project
System:	AUTOCAD	Typical Foundations Layout
Scale	—	
Sheet:	1 / 1	Format: A3 Dwg–Nr.: —

Drawing for Tender purpose
All dimensions are indicative only



Annex F

Insulator sets



- Notes:
1. The arcing rings will be guaranteed at thermal stability 50 kA for 1s
 2. Phase conductors configuration: 2 conductor per phase, spaced at 450mm
 3. The insulators protective air gap length distance (between arcing rings) will be chosen to withstand the lightning impulse voltage defined in Data Sheets
 4. All attachment dimensions and distances will be suitable for tower connection
 5. Total creepage distance per insulator set will be according to Data Sheets
 6. This drawing is for reference only. Bidder shall determine the required strength of insulators and overall string dimensions in accordance with technical data defined in Employer's Requirements.

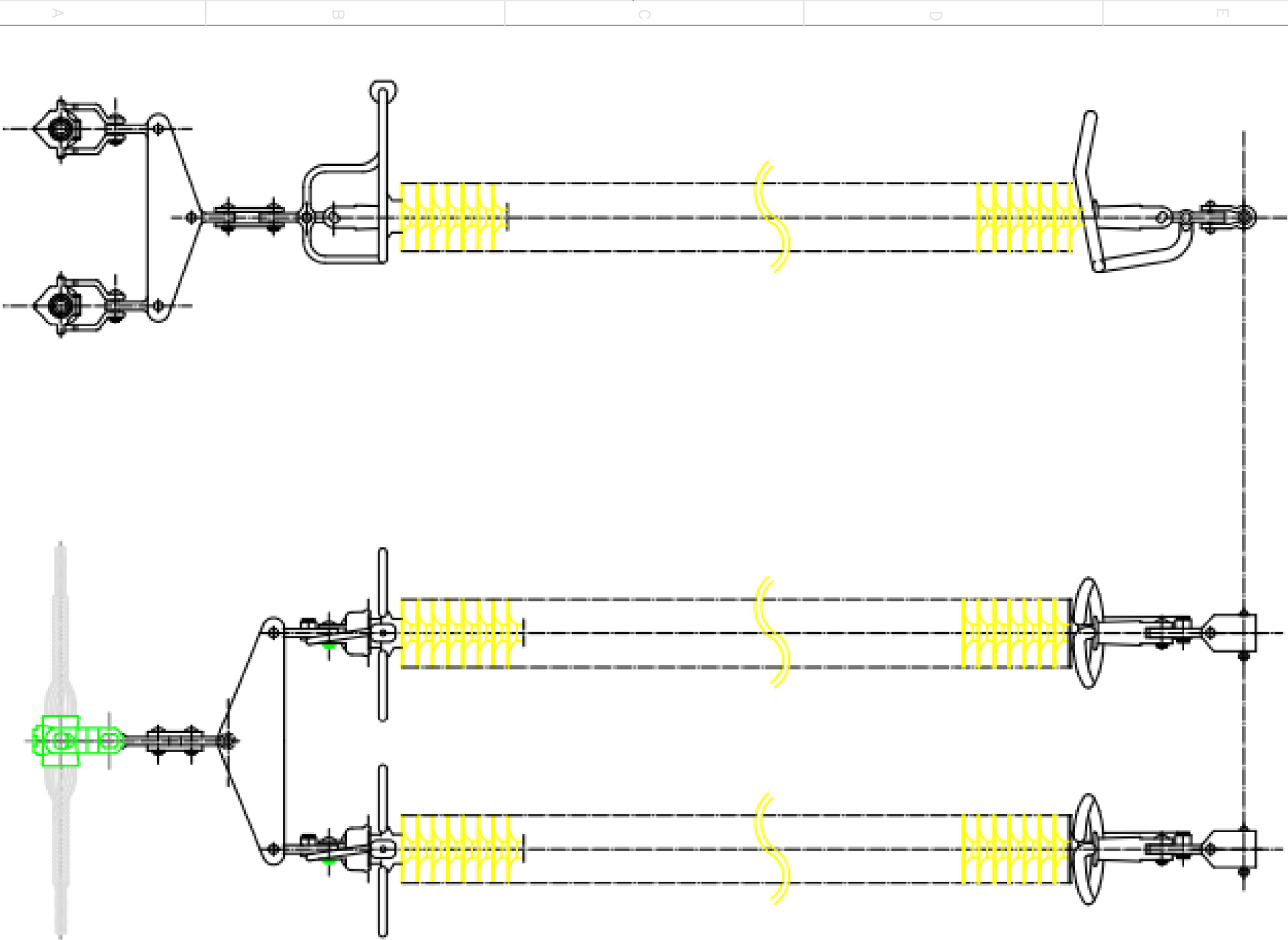
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	Date	Originator	Approver
Change notes			

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Project No.	4899A81	Consulting Services for Lekhnath–Damauli 220 kV Transmission Line Project	
Date:	11/2021		
System:	AUTOCAD		
Scale	—		
Sheet:	1 / 1	Format: A3	Dwg–Nr.: —



Annex G

Insulator sets



- Notes:
1. The arcing rings will be guaranteed at thermal stability 50 kA for 1s
 2. Phase conductors configuration: 2 conductors per phase, spaced at 450mm
 3. The insulators protective air gap length distance (between arcing rings) will be chosen to withstand the lightning impulse voltage defined in Data Sheets
 4. All attachment dimensions and distances will be suitable for tower connection
 5. Total creepage distance per insulator set will be according to Data Sheets
 6. This drawing is for reference only. Bidder shall determine the required strength of insulators and overall string dimensions in accordance with technical data defined in Employer's Requirements

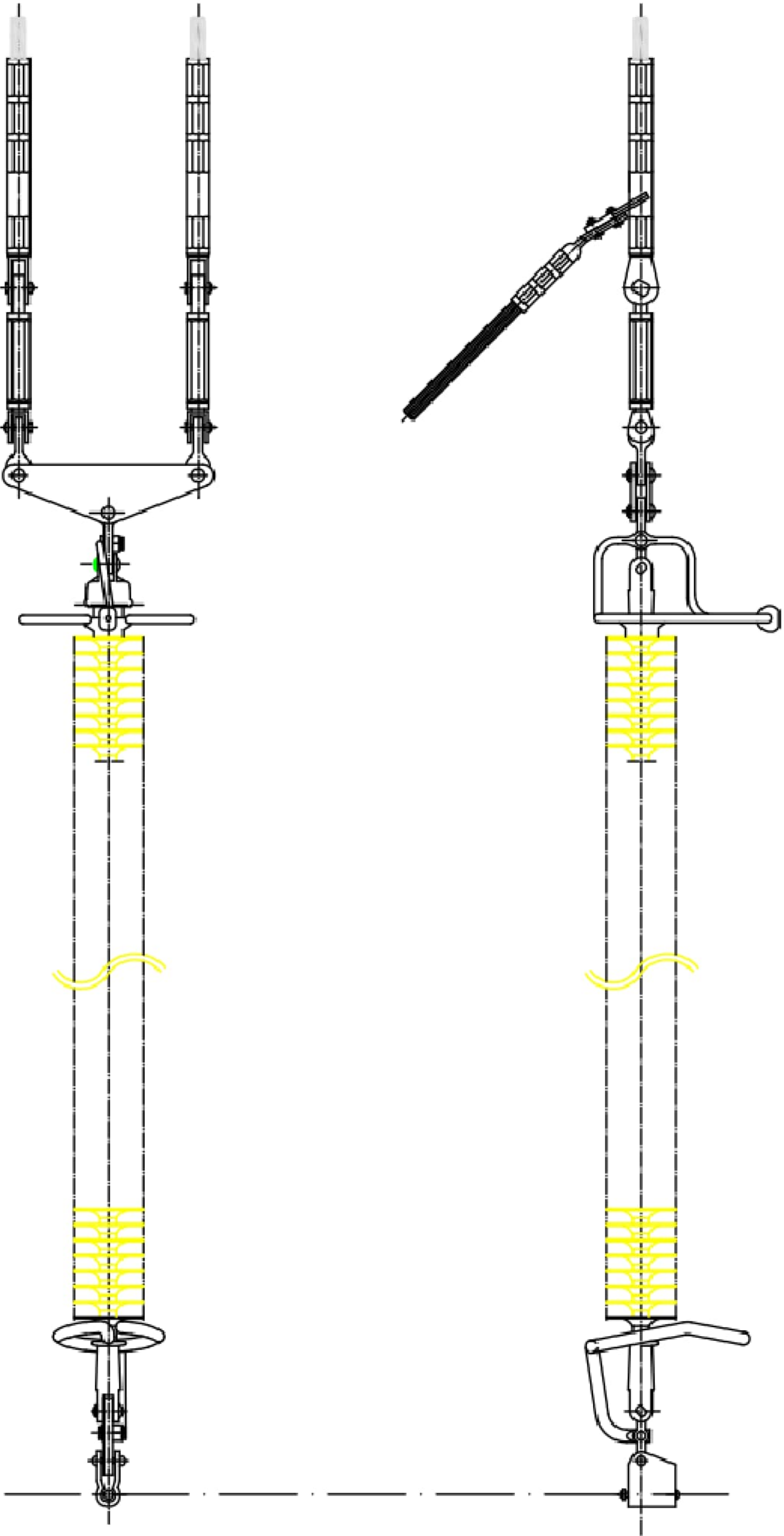
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	Date	Originator	Approver
Change notes			

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Project No.	4899A81	Consulting Services for Lekhnath–Damauli 220 kV Transmission Line Project	
Date:	11/2021		
System:	AUTOCAD		
Scale	—	Double Suspension Insulator String	
Sheet:	1 / 1	Format: A3	Dwg–Nr.: —



Annex H

Insulator sets



Notes:

1. The arcing rings will be guaranteed at thermal stability 50 kA for 1s
2. Phase conductors configuration: 2 conductor per phase, spaced at 450mm
3. The insulators protective air gap length distance (between arcing rings) will be chosen to withstand the lightning impulse voltage defined in Data Sheets
4. All attachment dimensions and distances will be suitable for tower connecting to Data Sheets
5. Total creepage distance per insulator set will be according
6. This drawing is for reference only. Bidder shall determine the required strength of insulators and overall string dimensions in accordance with technical data defined in Employer's Requirements.

Drawing for Tender purpose
All dimensions are indicative only

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0	11/2021	NICULAE	-	
	Date	Originator	Approver	Change notes

FICHTNER

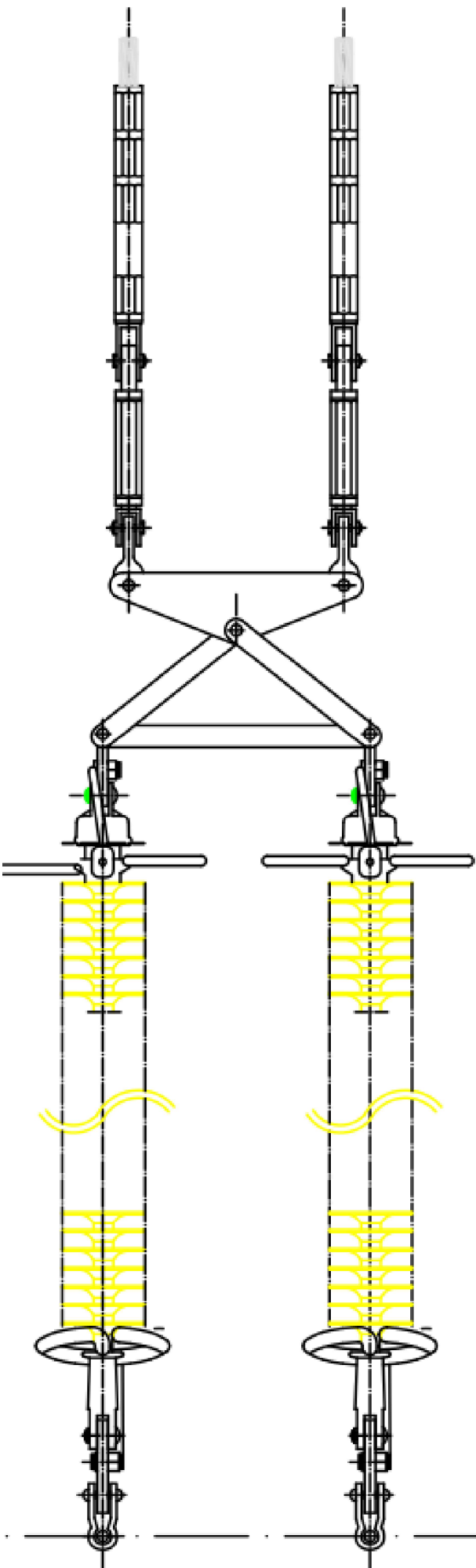
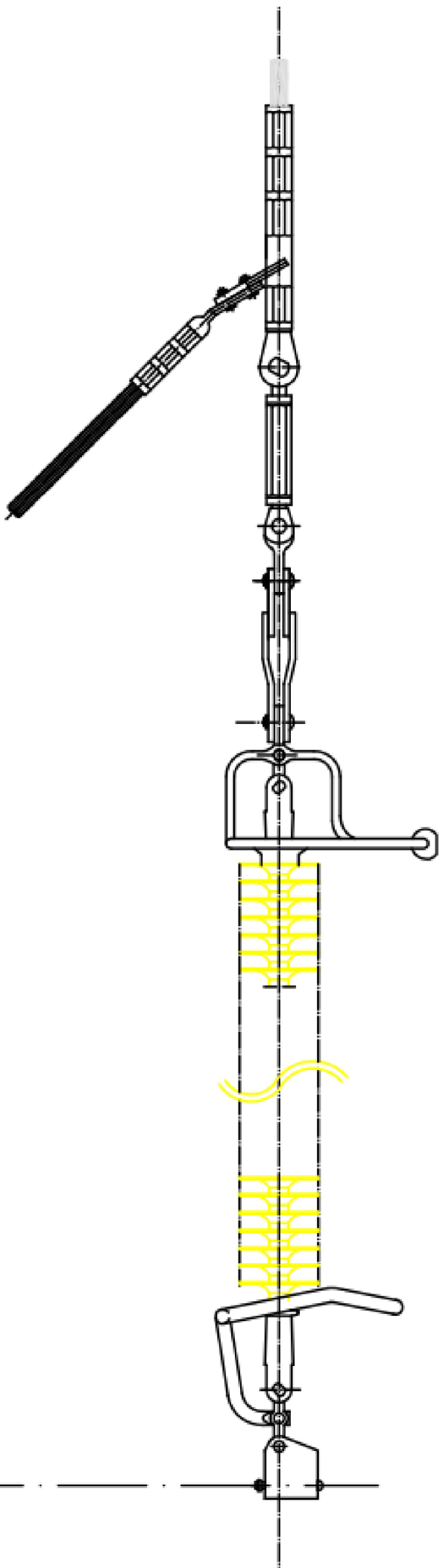


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Date:	11/2021	
System:	AUTOCAD	
Scale	—	Single Tension Insulator String
Sheet:	1 / 1	Format: A3 Dwg–Nr.: —



Annex I

Insulator sets



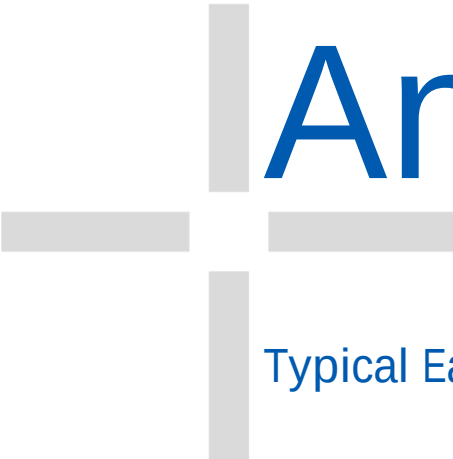
Notes:

1. The arcing rings will be guaranteed at thermal stability 50 kA for 1s
2. Phase conductors configuration: 2 conductor per phase, spaced at 450mm
3. The insulators protective air gap length distance (between arcing rings) will be chosen to withstand the lightning impulse voltage defined in Data Sheets
4. All attachment dimensions and distances will be suitable for tower connecting
5. Total creepage distance per insulator set will be according to Data Sheets
6. This drawing is for reference only. Bidder shall determine the required strength of insulators and overall string dimensions in accordance with technical data defined in Employer's Requirements.

Drawing for Tender purpose
All dimensions are indicative only

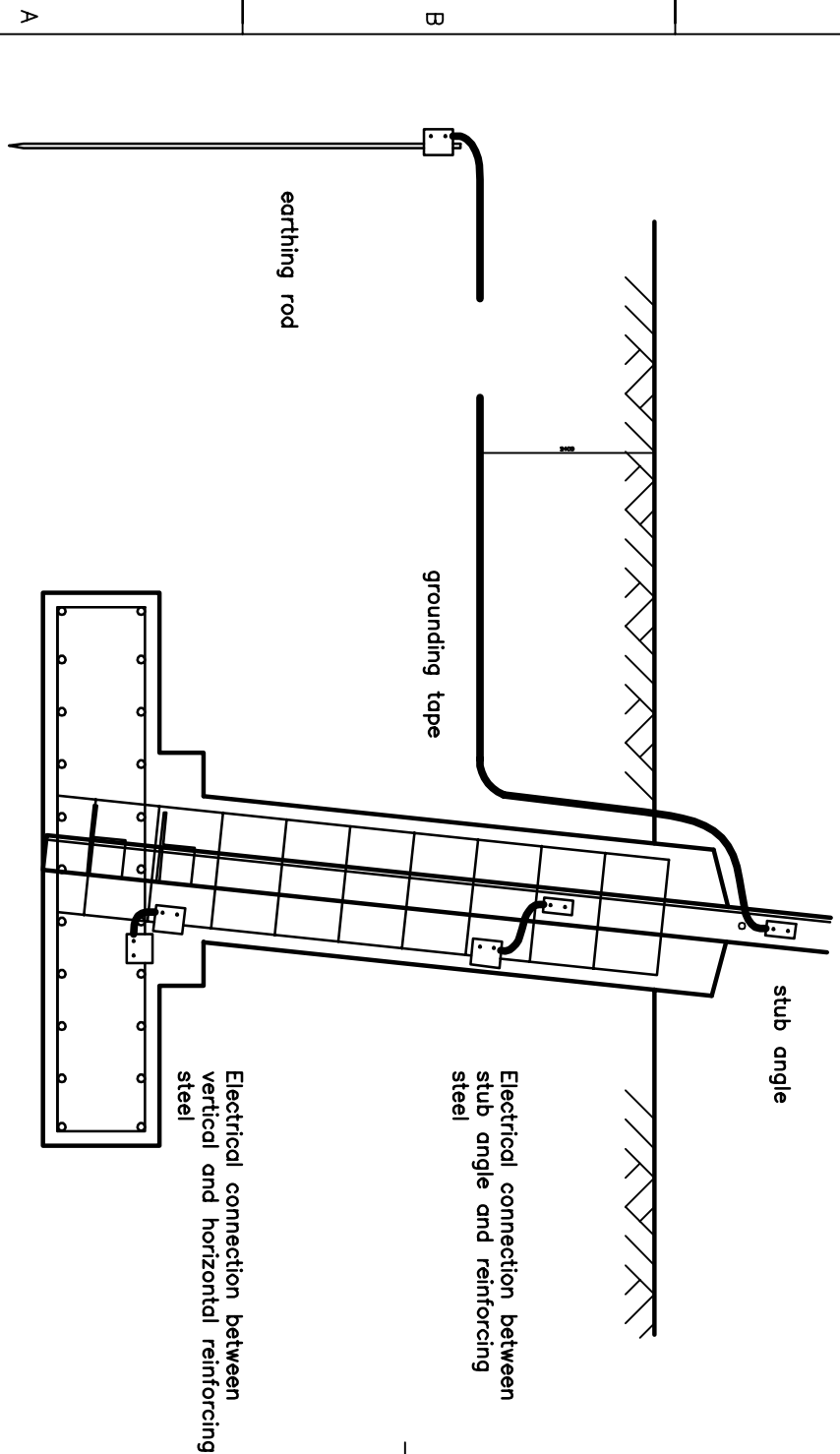
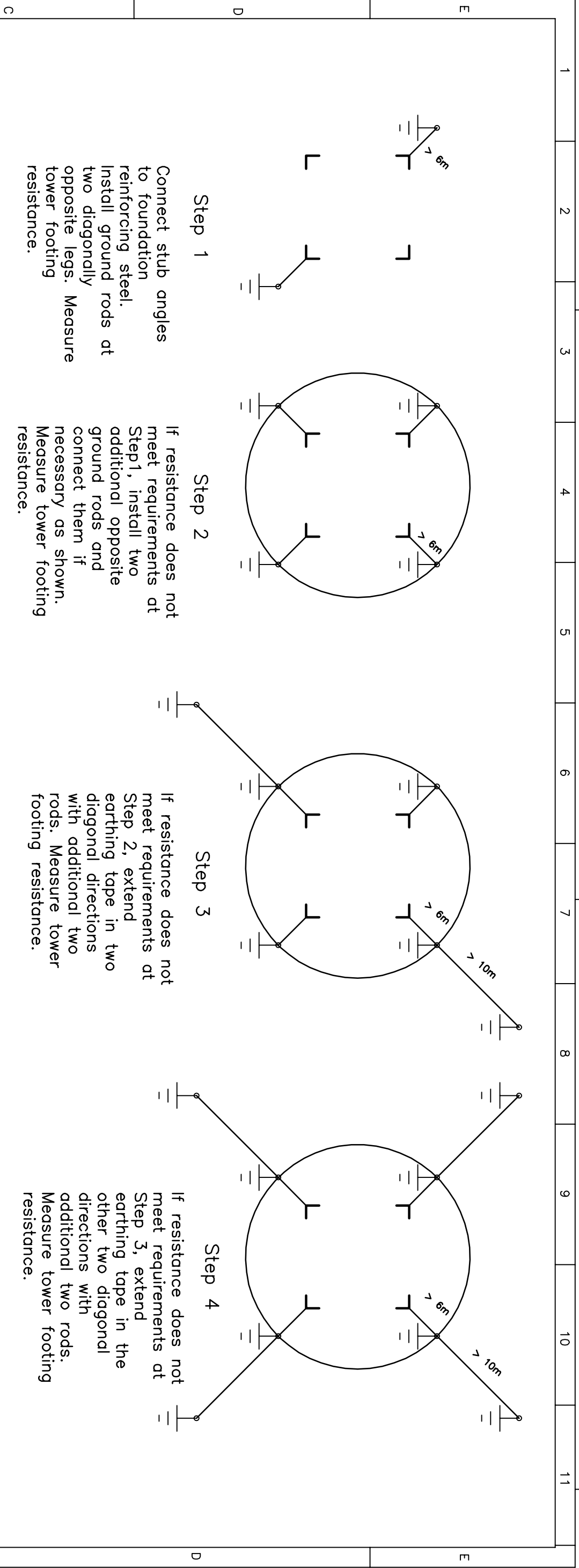
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Date	Originator	Approver	Change notes

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Project No.	4899A81	Consulting Services for Lekhnath–Damauli 220 kV Transmission Line Project	
Date:	11/2021		
System:	AUTOCAD		
Scale	—	Double Tension Insulator String	
Sheet:	1 / 1	Format: A3	Dwg–Nr.: —



Annex J

Typical Earthing System



Notes:

1. Step1 earthing shall be installed subsequent to excavation but prior to placement of foundations.
2. Additional steps if required, shall be installed after foundation works have been completed.
3. Earthing system shall comply with technical data defined in Employer's Requirements.

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Date		Originator	Approver	Change notes

FICHTNER

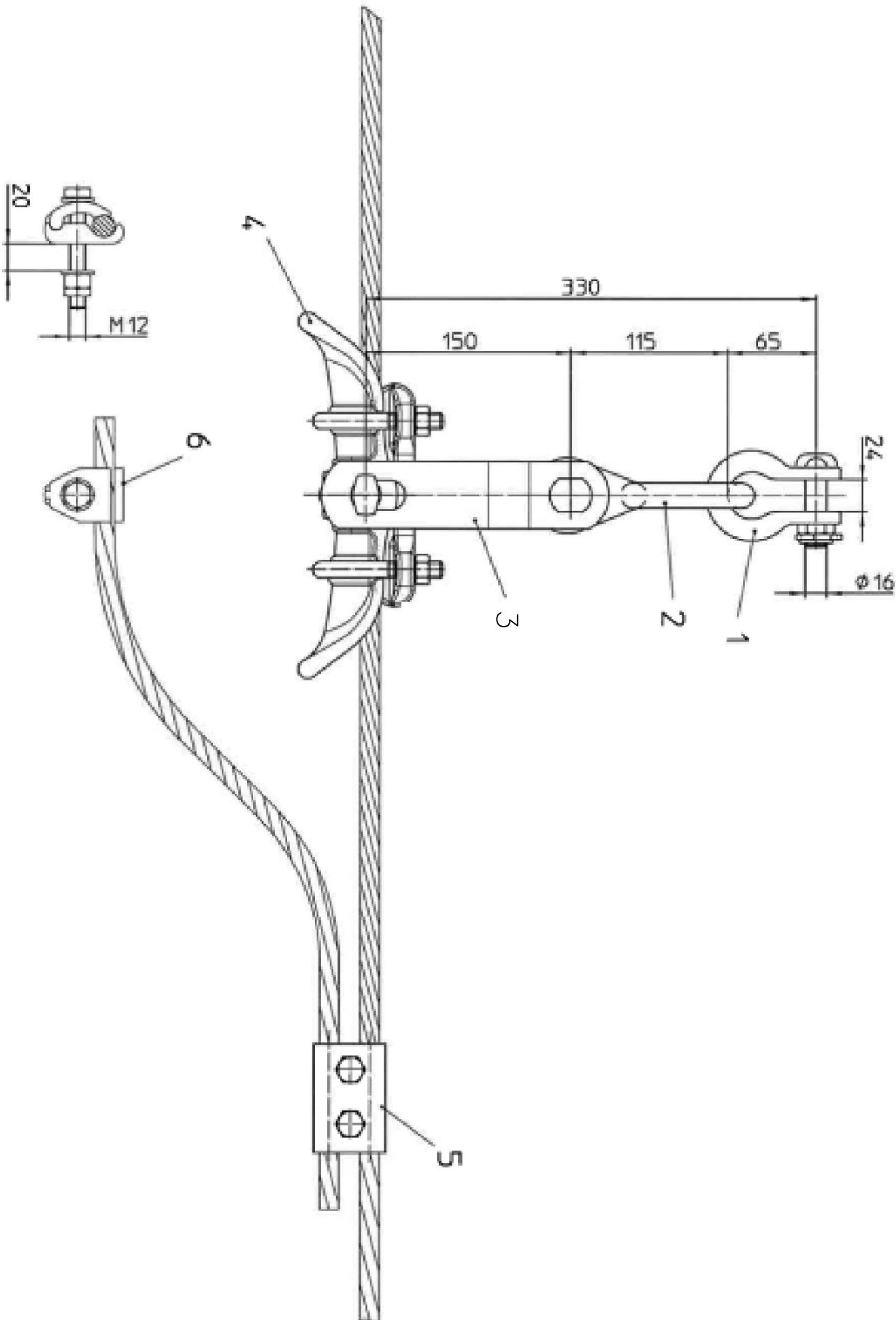
**NEPAL ELECTRICITY AUTHORITY**
नेपाल विद्युत प्राधिकरण

Project No.	4899A81	Consulting Services for Lekhnath–Damauli 220 kV Transmission Line Project	
Date:	11/2021		
System:	AUTOCAD	Typical Earthing System	
Scale	—		
Sheet:	1 / 1	Format: A3	Dwg–Nr.: —



Annex K

EW Attachment Sets



- LEGEND
1. Shackle
 2. Double Eye Twisted
 3. Strap Set
 4. Suspension Clamp
 5. Parallel Groove Clamp
 6. Tower Connection Clamp

- Notes:
1. All attachment dimensions and distances will be suitable for tower connection
 2. This drawing is for reference only. Bidder shall determine the required strength and dimensions of EW set in accordance with technical data defined in Employer's Requirements.

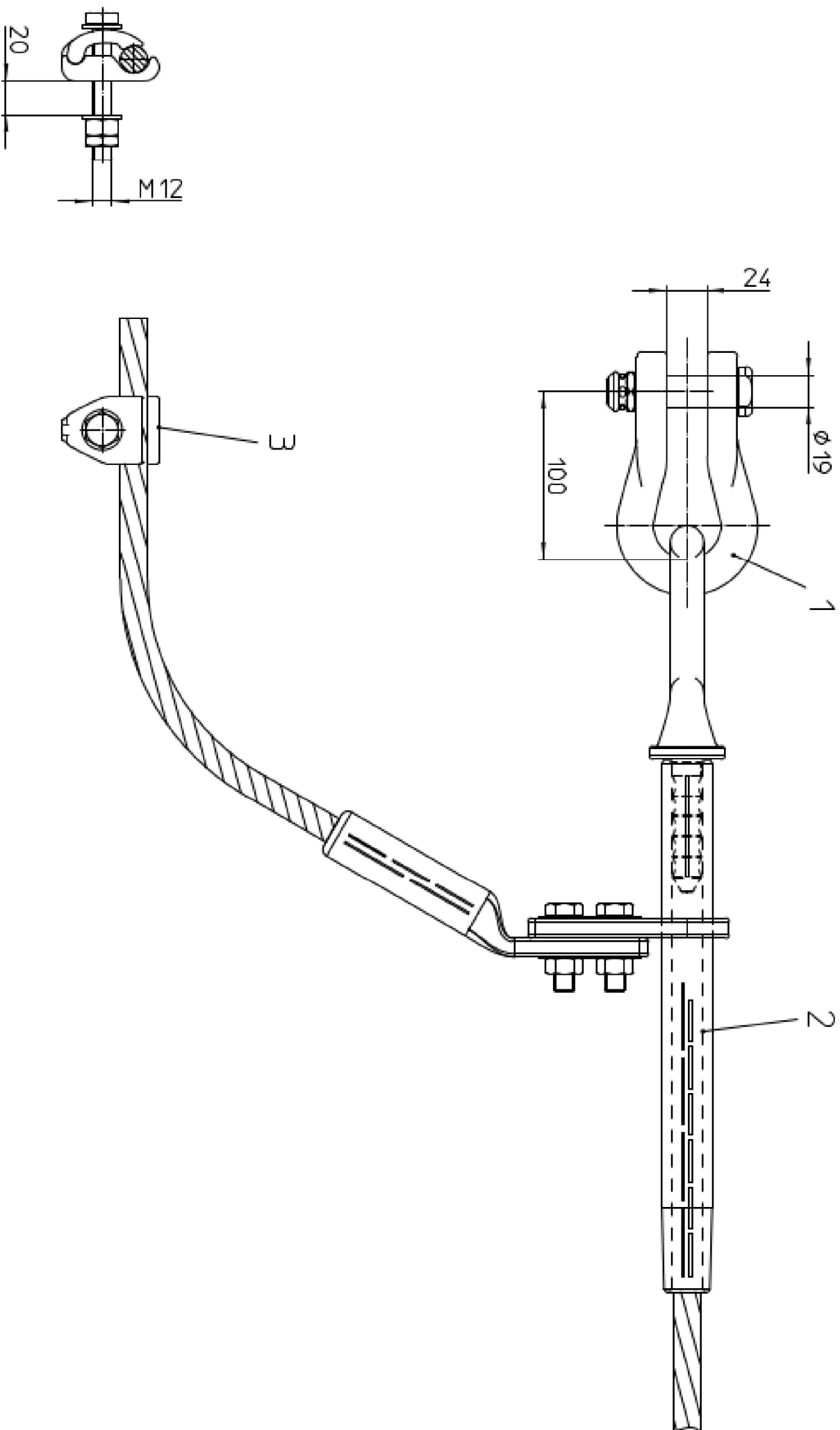
Drawing for Tender purpose
All dimensions are indicative only

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0	11/2021	NICULAE	-							
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Project No. 4899A81				Consulting Services for Lekhnath–Damauli 220 kV						
Date: 11/2021				Transmission Line Project						
System: AUTOCAD				Suspension set for Earthwire						
Scale —										
Sheet: 1 / 1				Format: A3	Dwg-Nr.: —					



Annex L

EW Attachment Sets



- 1. Shackle
- 2. Compression Dead End Clamp
- 3. Tower Connection Clamp

Notes:

1. All attachment dimensions and distances will be suitable for tower connection

2. This drawing is for reference only. Bidder shall determine the required strength and dimensions of EW set in accordance with technical data defined in Employer's Requirements.

Drawing for Tender purpose
All dimensions are indicative only

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0	11/2021	NICULAE	-	
	Date	Originator	Approver	Change notes

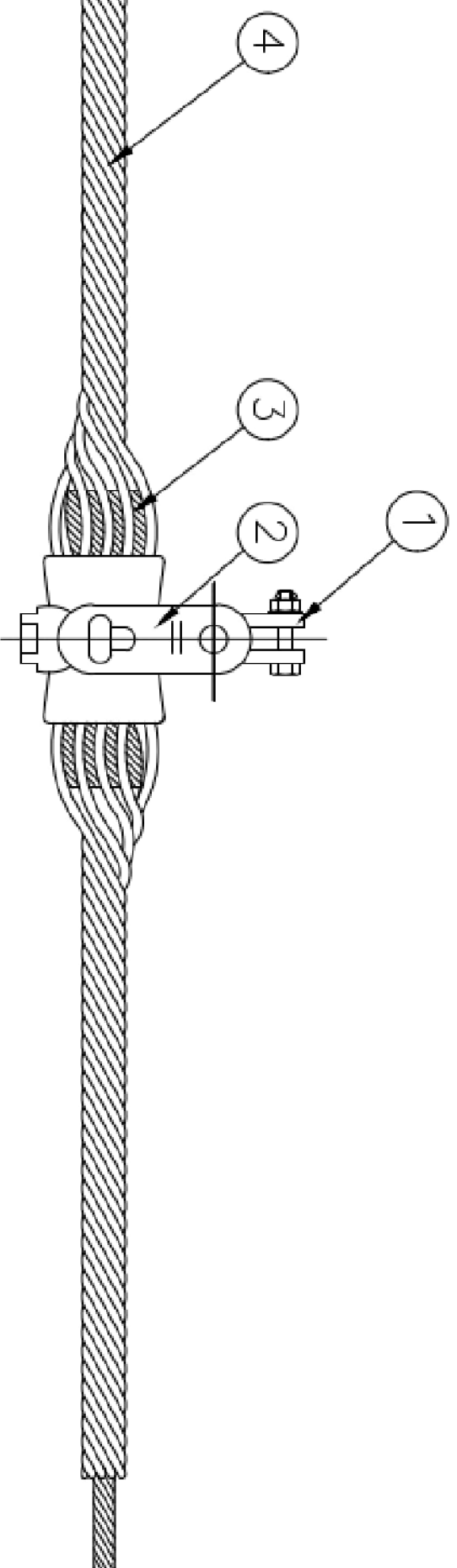
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Date:	11/2021	Tension set for Earthwire		
System:	AUTOCAD			
Scale	—			
Sheet:	1 / 1	Format: A3	Dwg-Nr.:	—



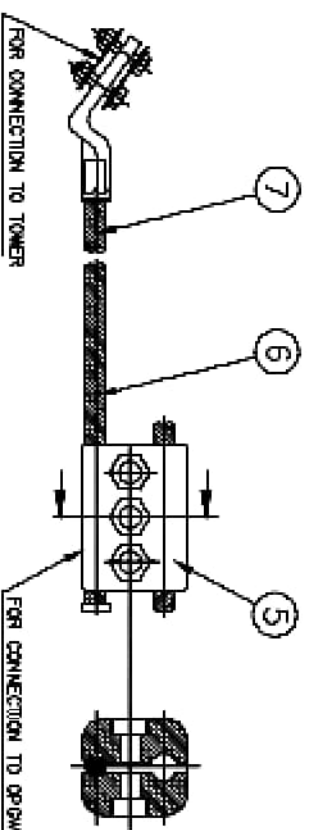
Annex M

OPGW Attachment Sets

OPGW SUSPENSION



EARTHING CONNECTION



LEGEND

1. Shackle
2. Suspension Clamp
3. Heoprene Support
4. Armor Rod
5. Parallel Groove Clamp
6. Earthing Cable
7. Compression Clamp with Earthing Lug

Notes:

1. All attachment dimensions and distances will be suitable for tower connection
2. This drawing is for reference only. Bidder shall determine the required strength and dimensions of OPGW set in accordance with technical data defined in Employer's Requirements.
3. Additional link devices (clevises) are recommended between Shackle 1 and the tower earthwire crossarm for more moving space
4. The Armor rod 4 shall allow for appropriate installation of vibration dampers

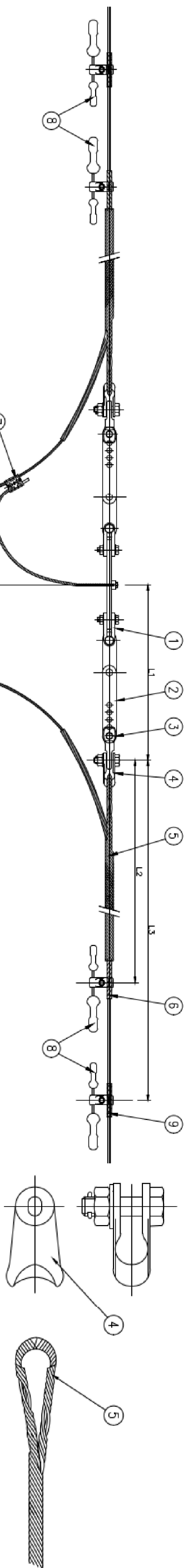
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	Date	Originator	Approver
Change notes			
FICHTNER			
Project No.	4899A81	Consulting Services for Lekhnath-Damauili 220 kV Transmission Line Project	
Date:	11/2021	OPGW Suspension Set	
System:	AUTOCAD		
Scale	-		
Sheet:	1 / 1	Format: A3	Dwg-Nr.: -

Drawing for Tender purpose
All dimensions are indicative only



Annex N

OPGW Attachment Sets



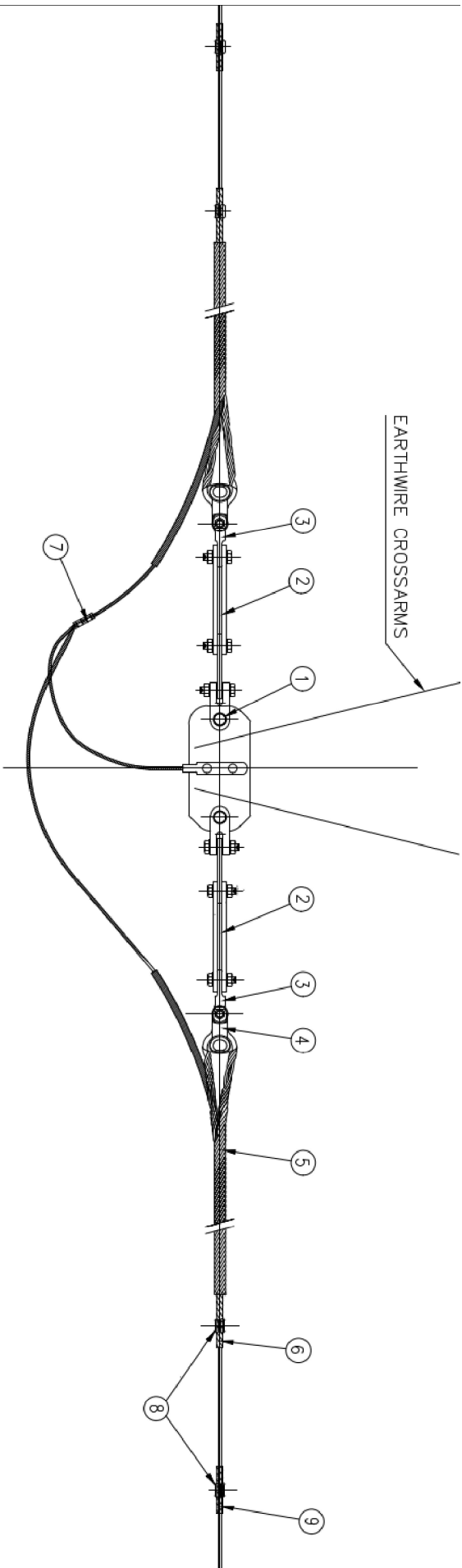
TOWER VERTICAL AXIS

LATERAL VIEW

DETAILS

LEGEND

- 1. Shackle
- 2. Extension Link
- 3. Twisted Double Strap
- 4. Fork Dead Eye
- 5. Dead End Spiral
- 6. Protection Spiral
- 7. Earthing Clamp
- 8. Vibration Damper
- 9. Armor Rod



UPPER VIEW

- Notes:
1. All attachment dimensions and distances will be suitable for tower connection
 2. This drawing is for reference only. Bidder shall determine the required strength and dimensions of OPGW set in accordance with technical data defined in Employer's Requirements.

Drawing for Tender purpose
All dimensions are indicative only

FICHTNER



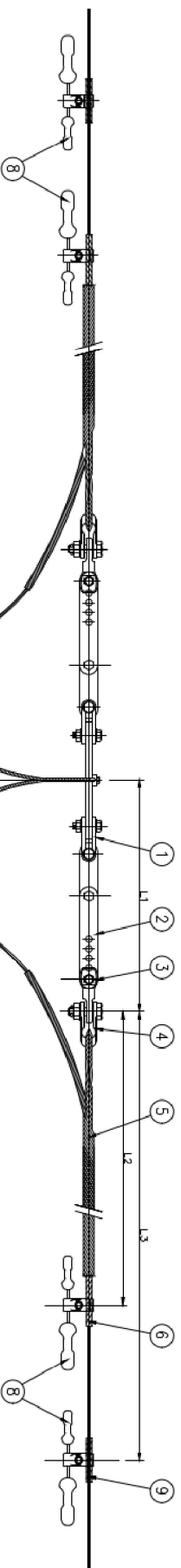
Project No.	4899A81	Consulting Services for Lekhnath–Damauli 220 kV Transmission Line Project
Date:	11/2021	
System:	AUTOCAD	

Scale	—	Tension set for OPGW (without connection to JB)
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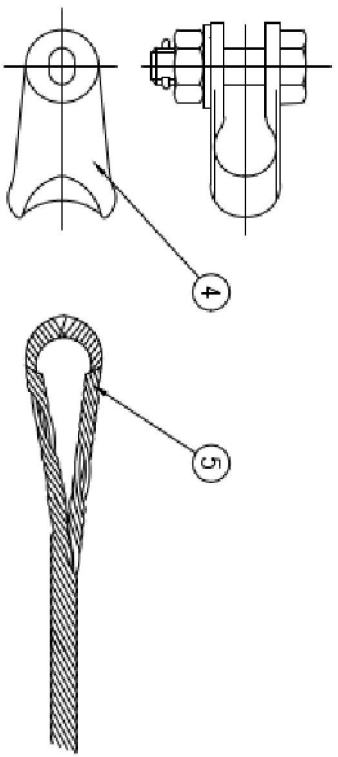


Annex O

OPGW Attachment Sets



LATERAL VIEW



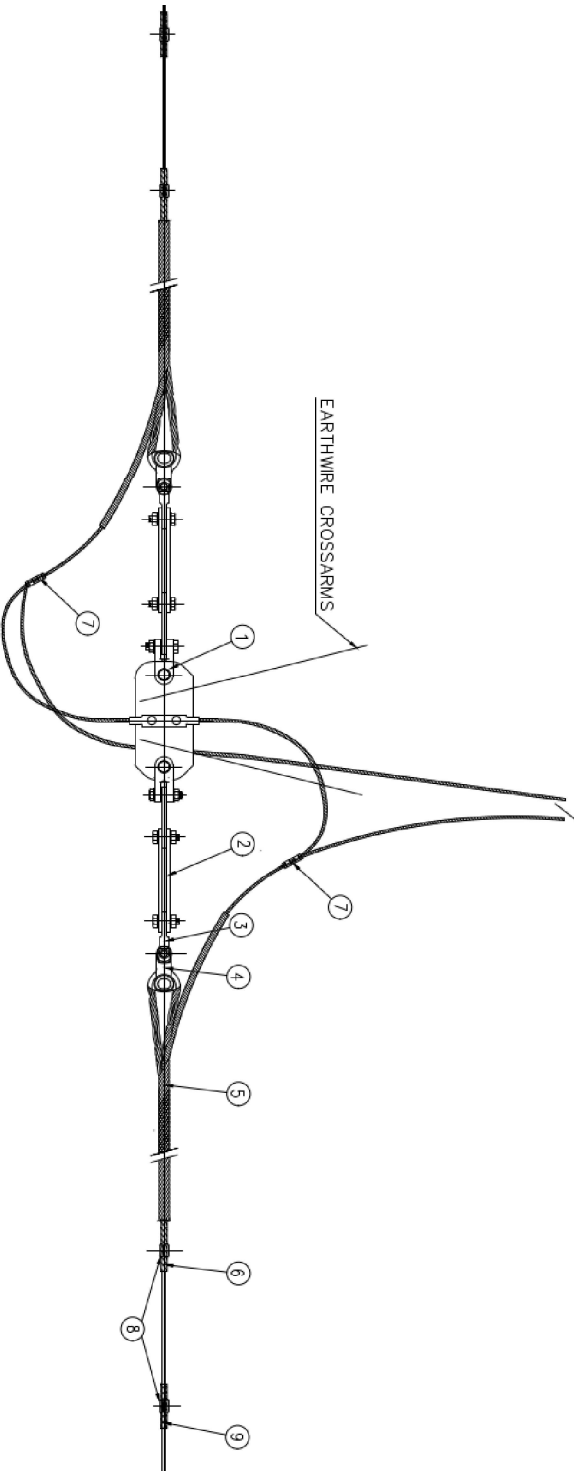
DETAILS

CONNECTION TO THE JOINT BOX

CONNECTION TO THE JOINT BOX

LEGEND

- 1. Shackle
- 2. Extension Link
- 3. Twisted Double Strap
- 4. Fork Dead Eye
- 5. Dead End Spiral
- 6. Protection Spiral
- 7. Earthing Clamp
- 8. Vibration Damper
- 9. Armor Rod



UPPER VIEW

Notes:

- 1. All attachment dimensions and distances will be suitable for tower connection
- 2. This drawing is for reference only. Bidder shall determine the required strength and dimensions of OPGW set in accordance with technical data defined in Employer's Requirements.

Drawing for Tender purpose
All dimensions are indicative only

FICHTNER



Project No.	4899A81	Consulting Services for Lekhnath–Damauli 220 kV Transmission Line Project
Date:	11/2021	
System:	AUTOCAD	
Scale	—	
Sheet:	1 / 1	

Tension set for OPGW (with connection to JB)

Format: A3	Dwg-Nr.: —
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Annex P

OHL/SS limit of scope of supply



Annex Q

Preliminary Geotechnical Investigation
elaborated for Bidding Purpose

**A REPORT
ON
GEO-TECHNICAL INVESTIGATION
OF
PROPOSED SITES OF
LEKHNATH & DAMAULI
SUBSTATIONS AND TRANSMISSION LINES**



**AT
KASKI AND TANAHUN DISTRICT**

Prepared For: Hydro-Consult Engineering Limited

Chaitra-2078

Submitted By;
R.R.P. Survey Consults Pvt Ltd.
Kathmandu

Project : Geotechnical Investigation of Lekhnath and Damauli Substations and Transmission		
Revision	Date	Details of Revision
0	8/12/2021	First Release
1	26/12/2021	Figure `1 : Location Plan of Boreholes in Google Earth
		Geological Description of Substation and TL differently
		Geological Map of Nepal in A3 Size
		Change in name of Code in chapter 5.2 under sampling
		Changes in Literatures under heading Dynamic Cone Penetration Test
		Figure 7 and 8 in A3 size
		Inclusion of Liquefaction Analysis for Borehole 3 for field condition
		Literature for Pile Foundation in Chapter 10
		Table of Bearing capacity for Isolated footing for 20 mm permissible Settlement for Different boreholes
		Table of Allowable Pile Capacity
		Recommendations for Embankment fillings
		Additional Photographs for Boreholes 2 and 6
		Correction in Depth name in Sieve Analysis calculation sheets of Borehole 9
2	1/4/2021	New google map of four new boreholes
		Table for name of additional boreholes with coordinates
		Geological description of new boreholes
		Coorection for diameter of boreholes
		Code mentioned under heading Dynamic Cone Penetration Test
		New chapter for Insitu Permeability Test included
		New chapter for Mechanical Tests included
		Change in liquefaction analysis of Borehole 3 as revision of field test was done
		New calculation sheets of liquefaction analysis of new boreholes
		Changes in table of liquefaction analysis with new boreholes results
		Change in allowable bearing capacity of Borehole 3 location
		Change in allowable pile capacity considering all the boreholes
		Table related to angle of friction for ew boreholes
		Literature related to location for filling materials
		Inclusion of New Borehole Logs and repeated Borehole 3 in Annex - I
		Inclusion of laboratory test results of New Boreholes and repeated Borehole 3 in Annex - II
		Inclusion of photographs of New Boreholes and repeated Borehole 3 in Annex - III

Table of Contents

1.	BACKGROUND.....	3
2.	COLLECTION AND REVIEW OF AVAILABLE DATA.....	6
3.	PLANNING OF WORKS	6
4.	GENERAL GEOLOGY AND GEOMORPHOLOGY.....	7
5.	GEO-TECHNICAL EXPLORATION	9
5.1	BORING	9
5.2	SAMPLING	9
5.3	FIELD TEST	10
5.4	GROUND WATER TABLE MONITORING	12
5.5	IN-SITU PERMEABILITY TEST	13
6.	LABORATORY TESTING, INTERPRETATIONS AND DETERMINATION OF DESIGN PARAMETERS.....	15
6.1	TESTS FOR DETERMINATION OF INDEX PROPERTIES	15
6.2	MECHANICAL TESTS	16
7.	SEISMICITY	17
8.	LIQUEFACTION.....	21
8.1	IDENTIFICATION OF LIQUEFACTION AREA	21
8.2	ANALYSIS OF LIQUEFACTION	22
8.3	CONCLUSION AND RECOMMENDATION.....	34
9.	ANALYSIS OF ALLOWABLE BEARING PRESSURE	35
9.1	SPT CORRECTION.....	35
9.2	ALLOWABLE BEARING CAPACITY FROM SHEAR FAILURE CRITERIA	36
9.3	ALLOWABLE BEARING PRESSURE FROM SETTLEMENT CRITERIA IN GRANULAR SOILS	37
9.4	ALLOWABLE BEARING PRESSURE BASED ON TOLERABLE SETTLEMENT IN COHESIVE SOILS.....	37
10.	PILE FOUNDATION.....	38
11.	RECOMMENDATION OF FOUNDATION TYPE AND DEPTH	39
12.	REFERENCES	53

Annex - I : Borehole Logs

Annex - II : Laboratory Test Results

Annex - III : Photographs

List of Figures

Fig 1: Location Plan of Boreholes in Google Earth

Fig 2: Geological map of Nepal including project area

Fig 3: Test Procedure of Standard Penetration Test

Fig 4: Schematic Description of Standard Penetration Test/Dynamic Cone Penetration Test

Fig 5: Reference point for measuring water level in borehole

Fig. 6: Historical events of Earthquakes (Source: Microseismic epicenter map of Nepal Himalaya and adjoining region, 1997 published by DoMG, GON).

Fig. 7: Geological map of Nepal (Dahal 2006)

Fig. 8: Probabilistic Seismic Hazard Assessment Map of the Nepal Himalaya

Fig 9: Seismic Zone Factor, Z (From Seismic Zoning Map of Nepal)

1. Background

This geotechnical investigation report (research) is prepared based on the site explorations and laboratory test results carried out by **R.R.P. Survey Consults Pvt. Ltd., Kathmandu** at the proposed sites of **Substations and Transmission Lines** in Kaski and Tanahun Districts, Gandaki Province. The investigation characterizes the subsurface conditions and develops the necessary requirement for the proposed safe bearing capacity of the proposed substation and transmission tower foundation. The boreholes are located at various locations of Kaski and Tanahun districts. The google map of location of the boreholes is shown in figure 1.

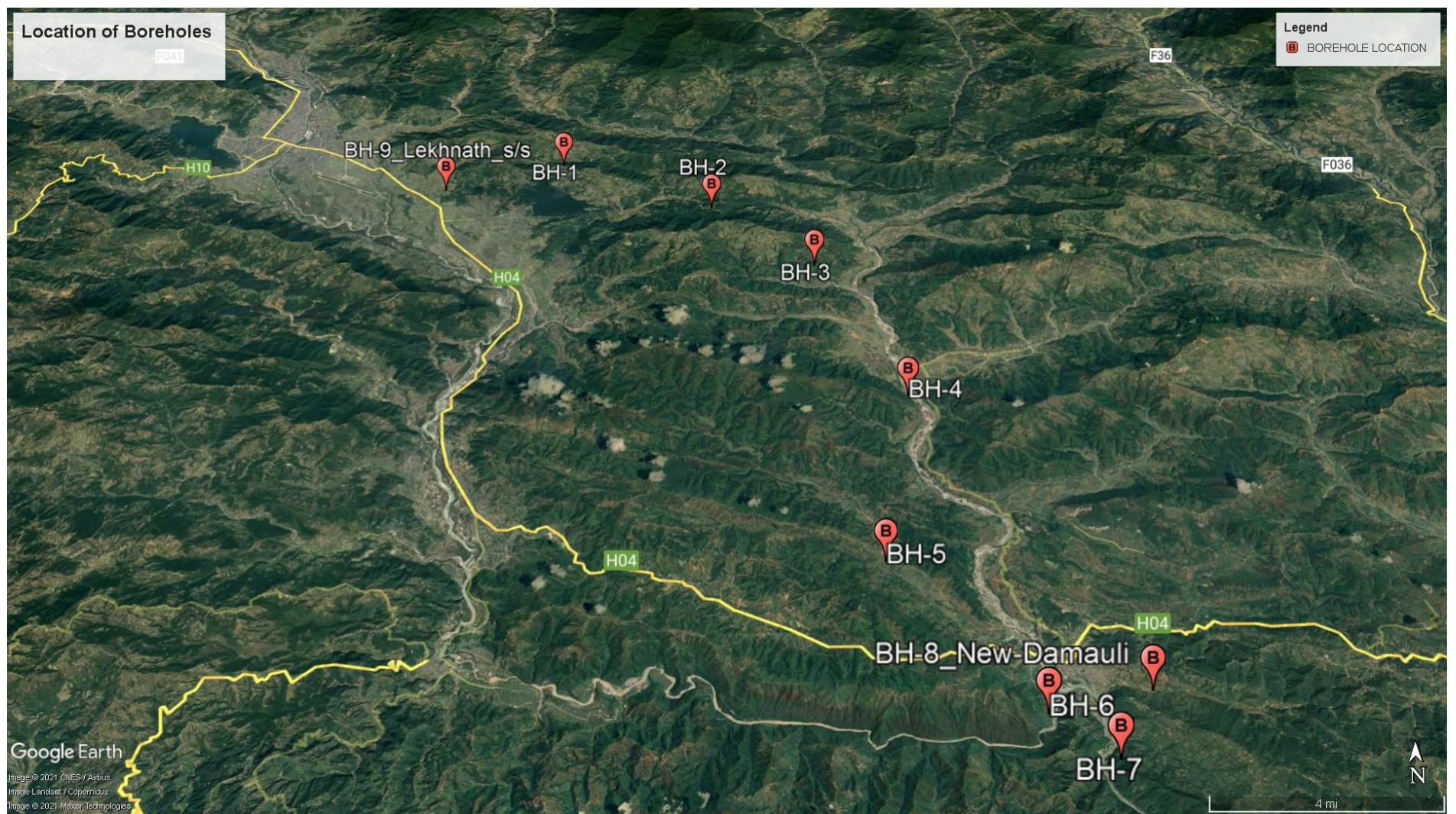


Fig 1: Location Plan of Boreholes in Google Earth

Table: List of Borehole with their coordinates

S.N.	BOREHOLE	COORDINATES
1	1	28°11'38.21"N 84°6'8.79"E
2	2	28°10'6.84"N 84°9'48.6"E
3	3	28°8'14.65"N 84°12'10.47"E
4	4	28°4'30.66"N 84°13'54.39"E
5	5	28°0'38.13"N 84°13'3.56"E
6	6	27°57'38.51"N 84°15'35.55"E
7	7	27°56'48.77"N 84°16'41.71"E
8	8	27°58'3.43"N 84°17'40.63"E
9	9	28°10'47.96"N 84° 3'22.89"E
10	1 – NEW-Damauli	27°58'3.14"N 84°17'33.52"E
11	2– NEW-Damauli	27°58'6.38"N 84°17'33.67"E
12	3 – NEW-Damauli	27°58'4.92"N 84°17'35.53"E
13	4 – NEW-Damauli	27°58'4.47"N 84°17'32.16"E

The soil investigation work for nine boreholes and additional four boreholes in Damauli Substation was carried out on month of Karthik and Mangsir, 2078 (October, 2021) and Falgun and Chaitra (February and March, 2022) respectively. The total quantity of soil investigation included six boreholes of fifteen meters depth in substations and seven boreholes up to depth of 6m wherever applicable as per the understanding. Standard Penetration Tests (SPT) and Dynamic Cone Penetration Tests (DCPT) were conducted at 1.5 m depth interval to furnish the compactness of the soil strata in the field.

The scope of work of present contract includes the following:

- ❖ Exploration of the subsurface soil formation and properties of soil at the site and conduct requisite in-situ tests like Standard Penetration Tests and Dynamic Cone Penetration Tests whichever is applicable depending upon the strata at site.
- ❖ Laboratory testing of representative samples obtained during the field investigation to evaluate relevant engineering parameters of the subsurface soils.
- ❖ Analysis of test results from in-situ and laboratory tests.

This report includes:

- ❖ Borehole logs
- ❖ Results of in situ and laboratory tests
- ❖ Assessment of Liquefaction susceptibility
- ❖ Perform Geotechnical Analysis and assessment of bearing capacity
- ❖ Recommendations of different suitable foundation types at different depths

2. Collection and review of available data

Site conditions, topographical and geological characteristic of the project area was grasped sufficiently through collecting and reviewing previously conducted soil investigation reports of nearby corridors, topographical map and geological map. Information stored in the form of maps, tables and published papers are collected from various sources.

3. Planning of works

Work schedule, location of these boreholes and other project specific issues were identified

based upon the KMZ file with location of the boreholes was provided to the drilling consultant. Immediately after finalization of foundations at site, drilling team finalized drilling methodology and revised methodology depending upon the changes on environment, geological and local conditions.

Table 1: Proposed Laboratory investigation of Soil

SPT samples (as per change in strata or if single strata at least 3 in each hole)	U/D samples (at least 1 in each hole if cohesive strata)
Natural Moisture test Specific Gravity test Liquid limit / Plastic Limit test Grain Size Distribution test Unit weight Direct shear test	Natural Moisture test Specific Gravity test Liquid limit / Plastic Limit test Grain Size Distribution test Unit weight/ Bulk density Uni-axial compression test Consolidation test

4. General Geology and Geomorphology

From the exploration record of the boreholes at different borehole locations can be acquired from borehole logs.

As per Geological map of Nepal, the project site of Lekhnath Substation, lies in **Lesser Himalaya** of Plio – Pleistocene to Quaternary age composed of fluvial/fluvioglacial gravels, conglomerates and lacustrine clay deposit. Borehole 1, 2, 3, 4 and 5 lies in lesser Himalaya under **Kuncha Group** of Precambrian age composed of mainly flyschoid sequence (bedded schists, phyllites and metasandstones), locally shallow water quartzite beds and basic sills and dykes present. Whereas, Damauli Substation, Borehole 6 and 7 lies in lesser Himalaya; under **Nawakot Group** of Precambrian to Lower Paleozoic consisting mainly shallow marine sediments, lower part dominantly clastic (phyllites, sandstones, quartzites and calcareous sandstones). Stromtolitic limestones and black slates occur in the upper part. Basic sills and dykes present.

Geological map of the project area is shown in Fig. 2. The map is an extract from Geological map of Nepal published by the Department of Mines and Geology of Government of Nepal.

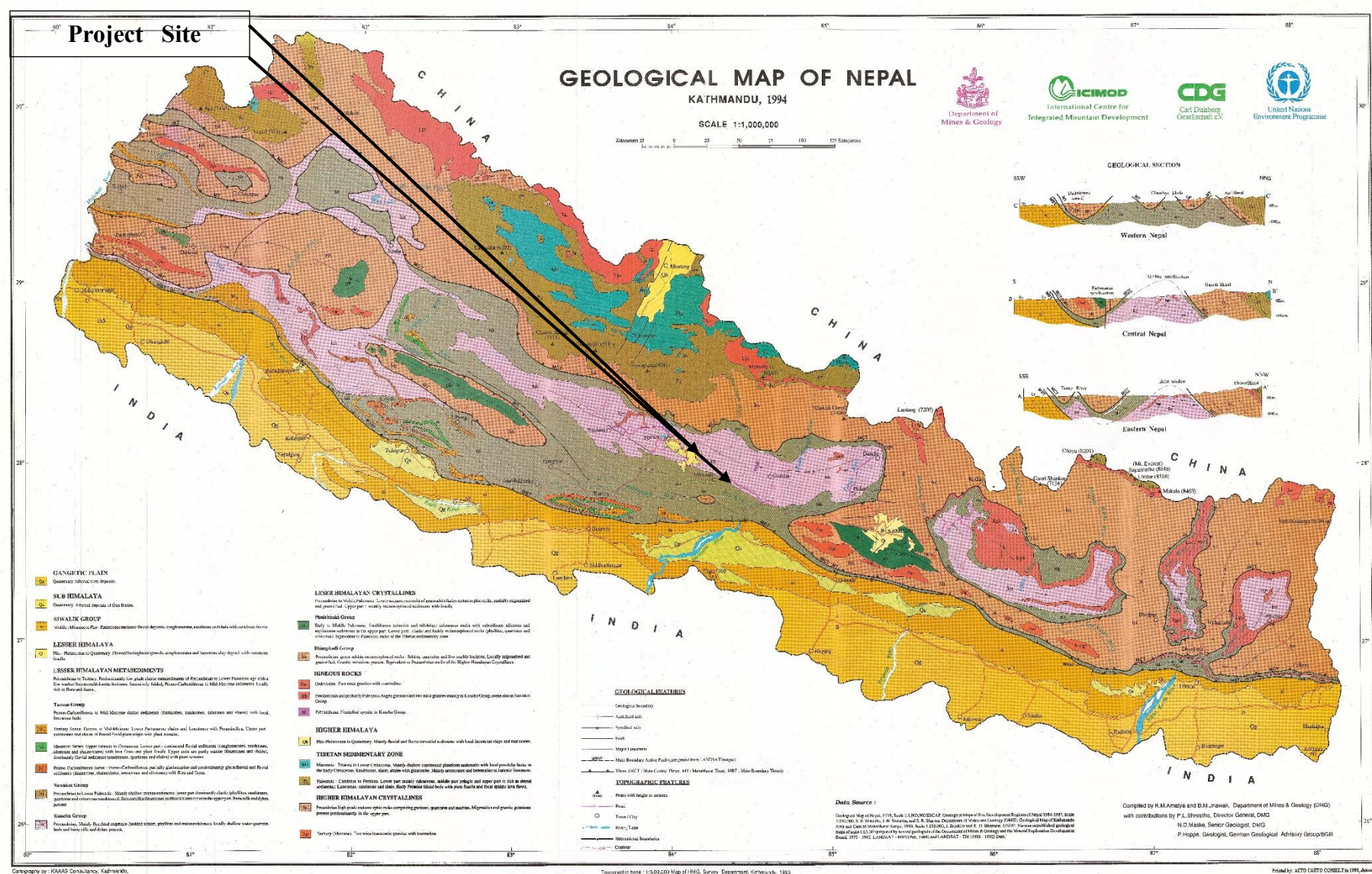
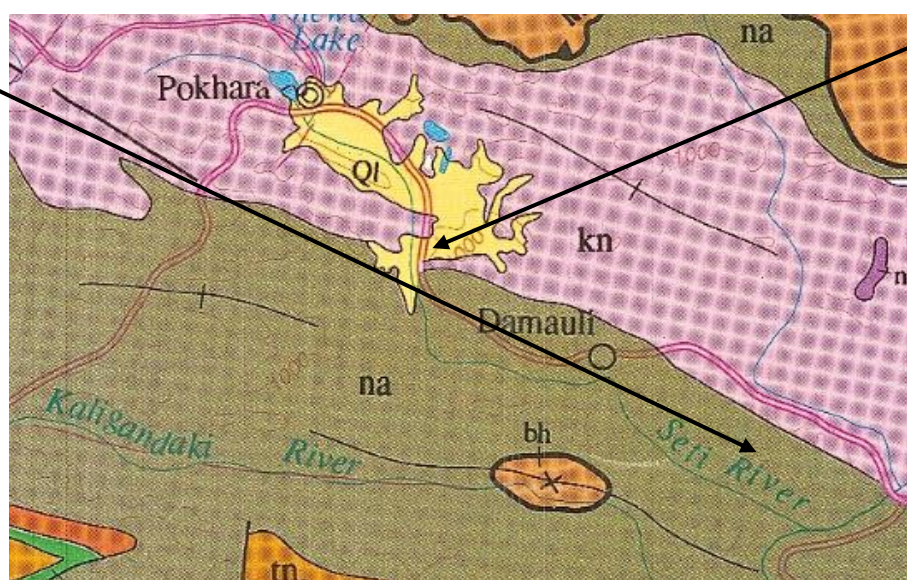


Fig 2: Geological map of Nepal including project area

**Damauli Substation- Borehole 8,
Borehole 1, 2, 3 and 4 (NEW)**

**Lekhnath
Substation-
Borehole 9**



LESSER HIMALAYA

Q

Plio - Pleistocene to Quaternary. Fluvial/fluvioglacial gravels, conglomerates and lacustrine clay deposit with vertebrate fossils.

Kuncha Group

kn

Precambrian. Mainly flyschoid sequence (bedded schists, phyllites and metasandstones), locally shallow water quartzite beds and basic sills and dykes present.

5. Geo-technical Exploration

Geological condition/stratum at the test site is important aspect to determine the depth, size and types of foundation. Drilling can define the characteristic and strength of soil and rock in both unstable and stable zones. Standard Penetration Tests and Dynamic Cone Penetration Tests carried out in different depths can give appropriateness of the densification of the soil strata.

On the basis of substation location and transmission tower locations, the drilling team was mobilized by Rotary Drilling Rig and Auger Set. Safety mechanisms were developed for technical team and workers with safety helmets and safety gloves while working.

5.1 Boring

Boring investigation was performed in the subsoil to abstract information of soil state, thickness and depth of layers etc. The subsoil distribution, fractured zone and soft ground shall be grasped for the foundation design of structures depending on boring test results. In addition, in-situ tests, sounding, and underground water level measurement were performed using boreholes.

The drilling works were carried out by Rotary drilling Rig and Auger Set. The diameter of borehole at borehole locations were of 96 mm and 100 mm. The boreholes were logged continuously in the field. The borehole logs included visual classification of soil, records of SPT for penetration of 450mm, DCPT for penetration of 300mm and position of ground water table. The borehole logs for site are presented in Annex-I including general ground water table.

5.2 Sampling

Before any disturbed samples were taken, the boreholes were washed clean to flush any loose disturbed soil particles deposited during the boring operation. The samples obtained in the split spoon barrel of SPT tube during Standard Penetration Tests were preserved as representative disturbed samples. The disturbed samples recovered in SPT tube were placed in air-tight double 0.5 mm thick transparent plastic bags, labeled properly for identification and finally sealed to avoid any loss of moisture. Only then, the samples were transportation to the laboratory for further investigations.

The test was conducted and samples were obtained as per **IS 2131: 1981 Method for Standard Penetration Test for soils**.

5.3 Field Test

The field test conducted at the site consists of Standard Penetration Test (SPT) and Dynamic Cone Penetration Tests (DCPT). They are the method for measuring soil characteristics of relative density and strength simply and quickly by penetrating resistance into the ground and pulling out it onto the ground. Penetration tests were executed through all strata.

Standard Penetration Test (SPT)

A standard split barrel sampler was used in the test. The tests were conducted in the boreholes of the site at a depth interval of every 1.5 m where sample can be extracted. The driving of split-spoon barrel was recorded at first 150 mm and then after at every 150 mm of penetration till the total penetration was 450 mm. The number of blows recorded for the first 150 mm of penetration is disregarded. The number of blows recorded for the last two 150 mm intervals are added and expressed as SPT N-value. The records of the SPT values obtained are presented in borehole logs in Annex-I.

Dynamic Cone Penetration Test (DCPT)

It consists of driving a cone by blows of hammers. The number of blows for driving the cone through a specified distance is a measure of the dynamic cone resistance. Dynamic Cone Penetration tests are performed by a 50-mm solid cone. (IS 4968: Part I). The driving energy is given by a 63.5 kg monkey hammer falling freely through a height of 750 mm onto the drive head. First of all, the cone is driven 100 mm into the soil at the bottom of the bore hole. It is then driven further 200 mm and the number of blows (Ncbr values) required to drive this distance is recorded.

The result i.e., Nc values first corrected to the Standard Penetration Test (SPT) value (N) and that provides and estimation of degree of compaction of soil strata, values of angles of internal friction (Φ) and allowable bearing capacity. The dynamic cone resistance is correlated with the SPT (N) as given below.

$$\begin{aligned} N_c &= 1.5 N \text{ for depth up to 3 m} \\ &= 1.75 N \text{ for depth 3 to 6 m} \\ &= 2 N \text{ for depth greater than 6 m} \end{aligned}$$

The records of the DCPT values obtained are also presented in borehole logs in Annex-I.

STANDARD PENETRATION TEST (SPT)

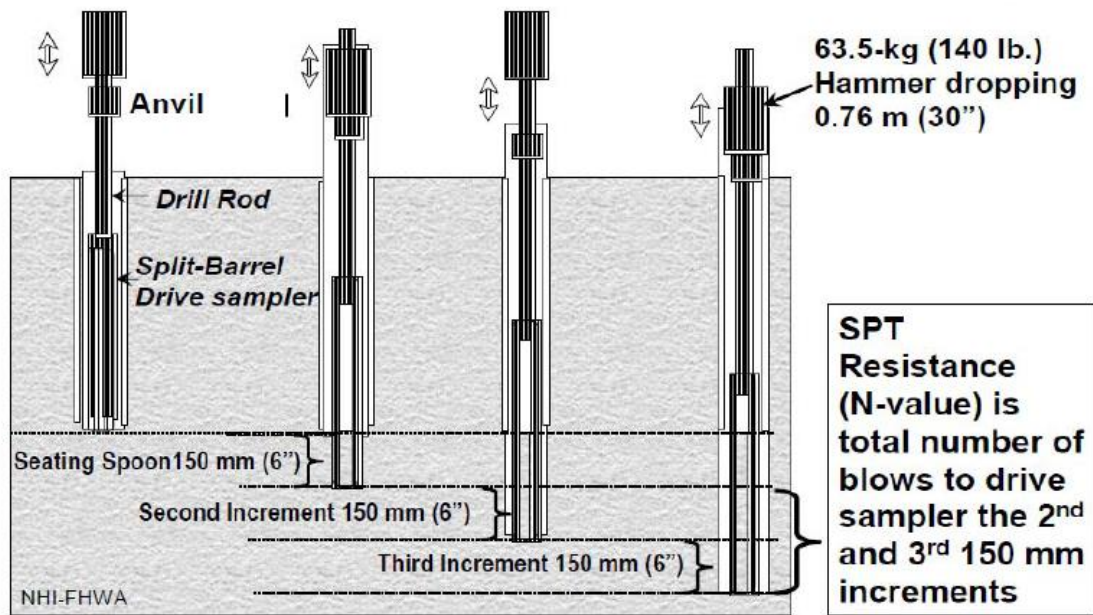


Fig 3: Test Procedure of Standard Penetration Test

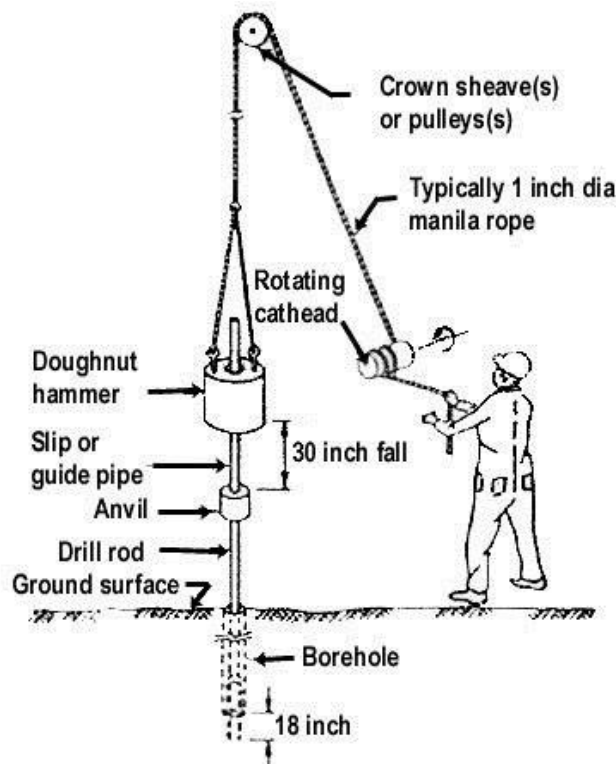


Fig 4: Schematic Description of Standard Penetration Test/Dynamic Cone Penetration Test

Table 2: Correlation between N-values and Internal Friction Angles in Granular Soils

N Value	Relative Density	Relative Density, D_r (%)	Internal friction angle, Φ	
			Peck (1974)	Meyerhof (1956)
< 4	Very loose	0.0 ~ 15	< 28.5	< 30
4 ~ 10	Loose	15 ~ 35	28.5 ~ 30.0	30 ~ 35
10 ~ 30	Medium	35 ~ 65	30.0 ~ 36.0	35 ~ 40
30 ~ 50	Dense	65 ~ 85	36.0 ~ 41.0	40 ~ 45
> 50	Very dense	85 ~ 100	> 41.0	> 45

In our analysis, Internal angle of friction was adopted as;

$$\phi = 15 + \sqrt{(12 * N \text{ corr.})} \text{ for sandy soils given by Dunham (1954)}$$

Table 3: Correlation between N-values to Consistency and Unconfined Compression Strength in Cohesive Soils

N Value	Consistency	Unconfined Compression Test, q_u in kN/m^2
< 4	Very soft	< 25
2 ~ 4	Soft	25 ~ 50
4 ~ 8	Medium Stiff	50.0 ~ 100
8 ~ 15	Stiff	100 ~ 200
15 ~ 30	Very Stiff	200 ~ 400
> 30	Hard	400 ~ 800

5.4 Ground water table monitoring

Water Table is defined as underground border between the grounds in which all spaces are filled with water and the ground above in which the spaces contain some air. The level of the water table tends to follow the shape of the overlying ground surface, rising under hills and dipping in valleys, but with a gentler slope than the ground. The level of the water table also varies with the climate, rising during rainy periods and falling during dry season.

The position of ground water table was measured at each borehole from the ground surface. The water level observed in the boreholes at the end of a 24 hours long period after completion

of boring work was taken as the position of ground water table. The depth to ground water table if observed are recorded in the borehole logs presented.

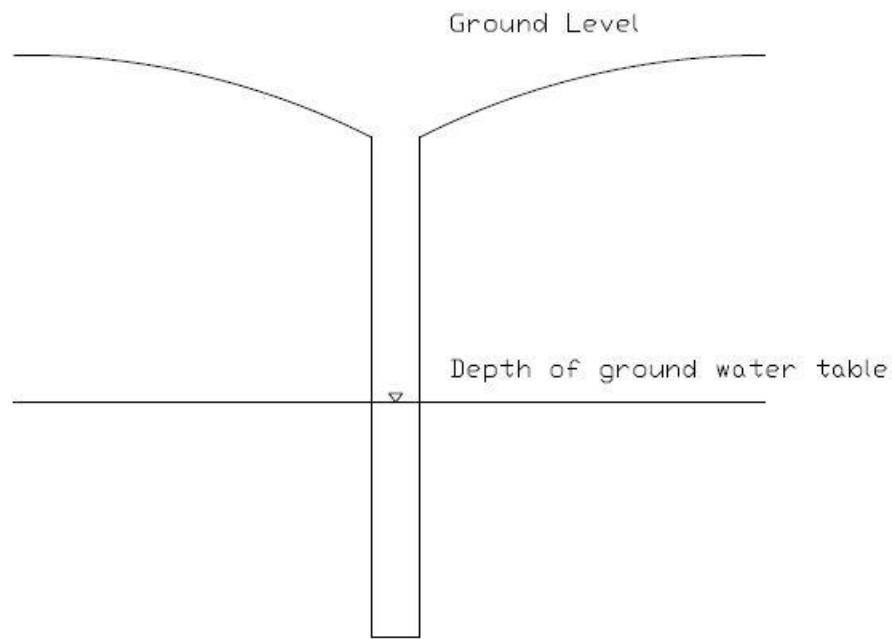


Fig 5: Reference point for measuring water level in borehole

5.5 In-situ Permeability Test

In-situ permeability tests were conducted to determine the water percolation capacity of the overburden soil. This test was performed inside the bore holes at an interval of two meters in all boreholes. The type of test was pump-in test.

Pump-in test (Constant Head Method)

The test was conducted in the bore holes by allowing water to percolate into the soil. Only clear water was used for conducting the test. Before conducting the test, the borehole was cleaned. Water was allowed to percolate through the test section for a sufficient period of time to saturate the soil before starting the observation.

Water was allowed into the borehole through a metering system ensuring gravity flow at the constant head to maintain a steady water level in the borehole. A reference mark was made at a convenient level which can be easily seen in the casing pipe to note down the fluctuations of water level. The fluctuations were counteracted by varying the quantity of water flowing into bore hole. The elevation of water was observed. The necessary observations such as flow rate, elevation of water surface above test depth, diameter of casing pipe etc. was made and recorded in proforma. The permeability by constant head method (open-end test) was obtained

from the following relation:

$$K=C1*Q/H$$

Where,

K = coefficient of permeability, cm/sec;

q = constant rate of flow into the hole, litre/min;

r = internal radius of casing; and

H = differential head of water in m = H₁ (gravity head) – H_f (head loss due to friction)

Values of C₁, which vary with the size of casing and rods obtained from Table 1 of IS 5529 (Part 1): 2013.

The value of H, for gravity test made below water table is the difference between the level of water in the casing and the ground water level. For test above water table, H₁ is the depth of water in the hole and H_f is neglected being a small value.

Note: The depths where the constant head couldn't be maintained in the boreholes and water falls down abruptly no falling head method was feasible, so litres of water flowing inside the borehole at the proposed depths for a given time was recorded to have idea of permeability values of the soil at that depth.

As the field permeability test couldn't be conducted due to rise of water up to the surface in all the boreholes 1,3 and 4 from depth 10 to 15 m. As the soil is silty sandy gravels with boulders; the permeability value of such deposits from various literatures is suggested in range of **0.0005 to 0.05 m/s**. (Reference: <https://www.geotechdata.info/parameter/permeability>)

The permeability values of soil at various depths at different borehole locations of Damauli Substation is tabulated below:

Table 4: Field Permeability Test Results at different borehole locations at various depths

BOREHOLE 1 - NEW							
Depths	2	4	6	8	10	12	14
Permeability,k,cm/s	0.1048	0.0804	0.0678	0.0657	No tests could be performed due to water level rise to the ground level		
BOREHOLE 2 - NEW							
Depths	2	4	6	8	10	12	14
Permeability,k,cm/s	0.2958	0.2530	0.0608	0.4051	0.4098	0.3397	0.2901
BOREHOLE 3 - NEW							
Depths	2	4	6	8	10	12	14
Permeability,k,cm/s	0.1060	0.1111	0.1418	0.2643	No tests could be performed due to water level rise to the ground level		
BOREHOLE 4 - NEW							
Depths	2	4	6	8	10	12	14
Permeability,k,cm/s	0.1388	0.1583	0.1442	0.0604	No tests could be performed due to water level rise to the ground level		

6. Laboratory Testing, Interpretations and Determination of Design Parameters

Disturbed and undisturbed samples are tested to get the physical characteristics and mechanical properties. To identify the properties, laboratory soil tests were performed.

6.1 Tests for determination of index properties

Standard laboratory tests were carried out to characterize the soil strata. The laboratory tests included the following: Grain Size Analysis, Natural Moisture Content, and Specific Gravity. Depending upon the type of soil and the scope of works, type and number of the laboratory tests were determined in consultation with the Geotechnical Engineer. All the requisite laboratory tests were carried out in accordance with IS standard specifications mentioned as follows:

Moisture Content-IS 2720: Part 2: 1973: Part 2; Grain Size Analysis-IS 2720: Part 4: 1985: Part I; Specific Gravity-IS 2720: Part 3: Sec 1: 1980: Part 3.

Grain Size Analysis

Grain size distribution was determined by dry and wet mechanical process. Sieve analysis was carried out by sieving a soil sample through a set of sieves kept one over the other, the largest size being kept at the top and the smallest size at the bottom. The soil retained on each sieve

was weighed and expressed as a percentage of the weight of sample. Finally, the gradation curve was found with % finer and corresponding particle size (D), dia. Further Uniformity Coefficient (C_U), Coefficient of Curvature (C_C) along with D_{10} (Ten percent of the soil particles are finer than this size), D_{30} (Thirty percent of the soil particles are finer than this size), D_{50} (Fifty percent of the soil particles are finer than this size) and D_{60} (Sixty percent of the soil particles are finer than this size).

Natural Moisture Content

The natural moisture content was determined from samples recovered through the split spoon sampler and disturbed samples.

Atterberg's Limit

Liquid Limit and Plastic Limit Tests were conducted in soil with cohesive nature as per Indian standards.

Specific Gravity Test

The specific gravity test was conducted of the soil samples which passes the No. 200 mm sieve. The pycnometer method is widely used in the laboratory test for finding out Specific Gravity (G) value.

6.2 Mechanical Tests

Generally, some sets of soil samples were selected assuming similar in situ layers and conducted laboratory tests from each borehole in order to discern the shear related strengths and stress-strain responses of soils. All the laboratory tests were numbered sequentially. The test number and the prefix were used as test and specimen identifiers.

Direct Shear Test

Direct shear tests were conducted on disturbed samples collected from the borehole. Some of the samples obtained from the borehole was used to carry out direct shear test. The samples were carefully extruded from the sampling tubes and molded using standard moulds of 6.0 x 6.0 cm² cross-sectional areas and trimmed to 2.5 cm high. Solid metal plates were placed on both surfaces of the samples to prevent the dissipation of pore water during shearing. The direct shear equipment is mechanically-operated, and shearing applied at constant strain rate. If the samples are cohesive they will be sheared at a relatively fast rate (duration of tests less than 10 minutes) to maintain un-drained condition. The samples were sheared at three

different normal stresses. The direct shear test results are presented in terms of the failure envelopes to give the angle of internal frictions (ϕ) and the cohesion intercepts(c). Here, in our analysis the strata are cohesionless sand, so cohesion intercept is neglected.

Note for other lab tests: Trials for undisturbed sampling were carried out but samples weren't collected in the undisturbed sampling tubes. So, an assessment of the consolidation characteristics of the soil at the substation site cannot be carried out due to presence of sandy strata.

7. Seismicity

Many earth scientists believe that longitudinally the entire 2,400 km long Himalayan arc can be segmented into different individual parts (200-300 km) which periodically break and move separately and produce mega earthquake (catastrophic earthquake) in the Himalayan region. From east to west, the great earthquake of Assam, India (1950), Shilong, India (1897), Nepal-Bihar, India (1934) and Kangra, India (1905) are the mega-earthquakes of the last century produced by the movements in different parts of the Himalayan arc, all with magnitude around 8.0. When a sector of the Himalaya moves and produces earthquakes, it will take some time (from decades to century) to repeat the event at the same place. Nepal is prone to an earthquake of minor or major magnitude. Records of earthquakes since 1253 indicate that Nepal was hit by 16 major earthquakes - the 1833 (magnitude 7.9) and 1934(magnitude 8.3) are two of these which have occurred at an interval of 100 years. Statically, the earthquake occurrence data of the last century shows that in average Nepal was hit by a big earthquake in every 12 years (Nakarmi, 1997).

Statistics shows that 1934 earthquake was the severest for Kathmandu valley where significant damages to the lives and properties were observed. Recently devastating earthquake in April 25th, 2015 causing significant damages to life and properties of the people. The frequency and intensity of earthquakes are found at the weakness of the crust such as major faults and major bends. Location of Nepal in the Himalaya along with major tectonic boundary and various longitudinal zones of the Himalaya is shown in Fig.7.

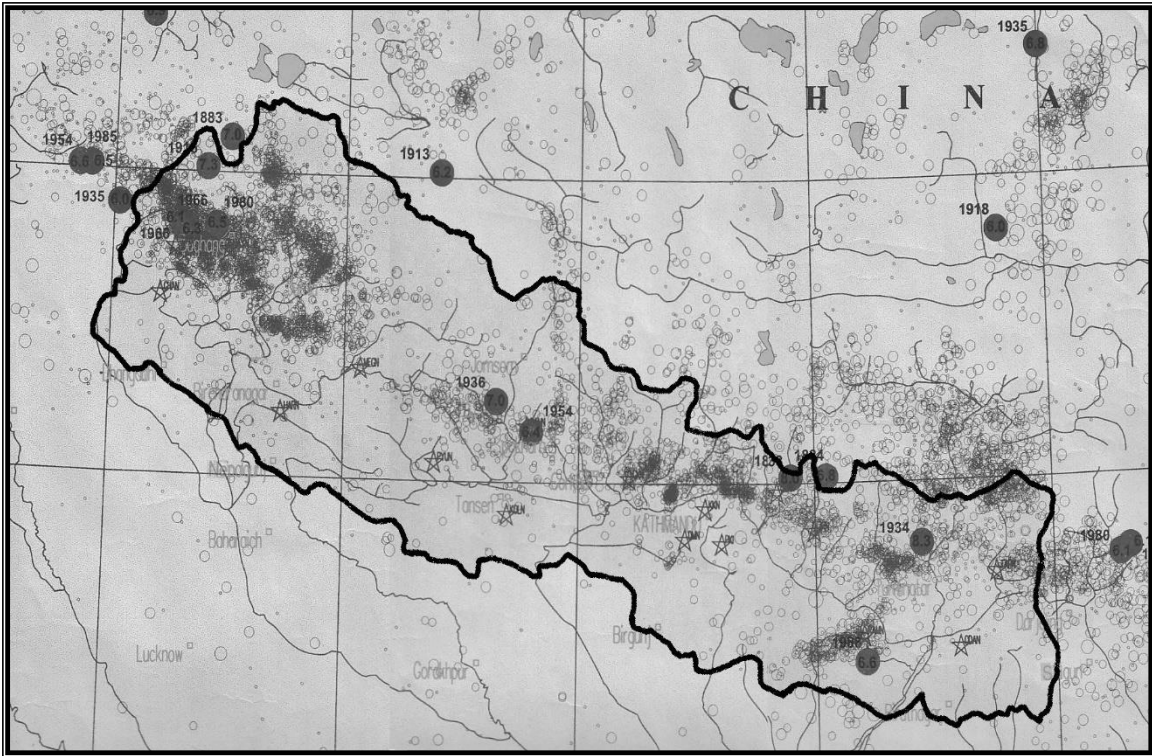


Fig. 6: Historical events of Earthquakes (Source: Microseismic epicenter map of Nepal Himalaya and adjoining region, 1997 published by DoMG, GON).

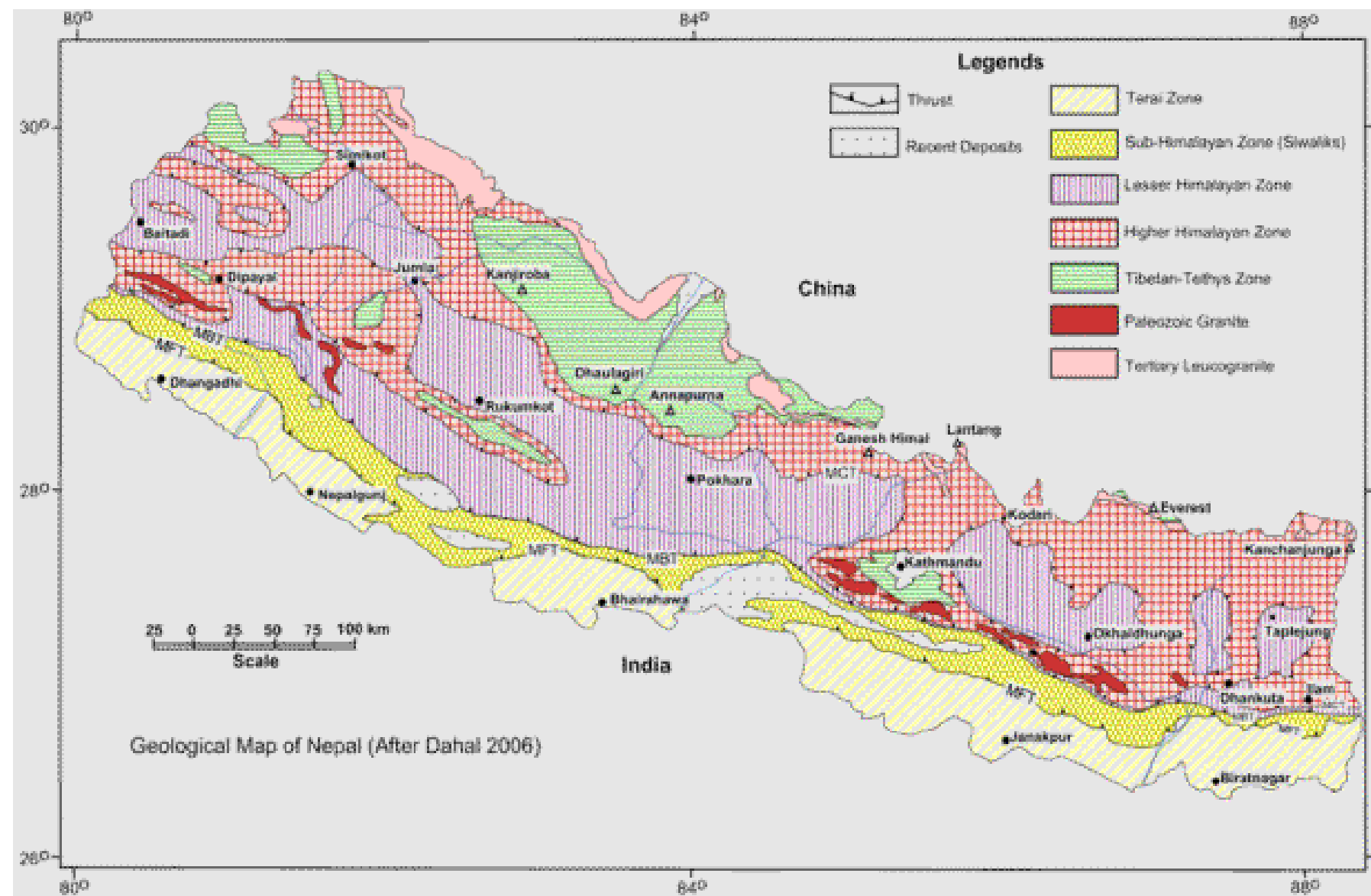


Fig. 7: Geological map of Nepal (Dahal 2006)

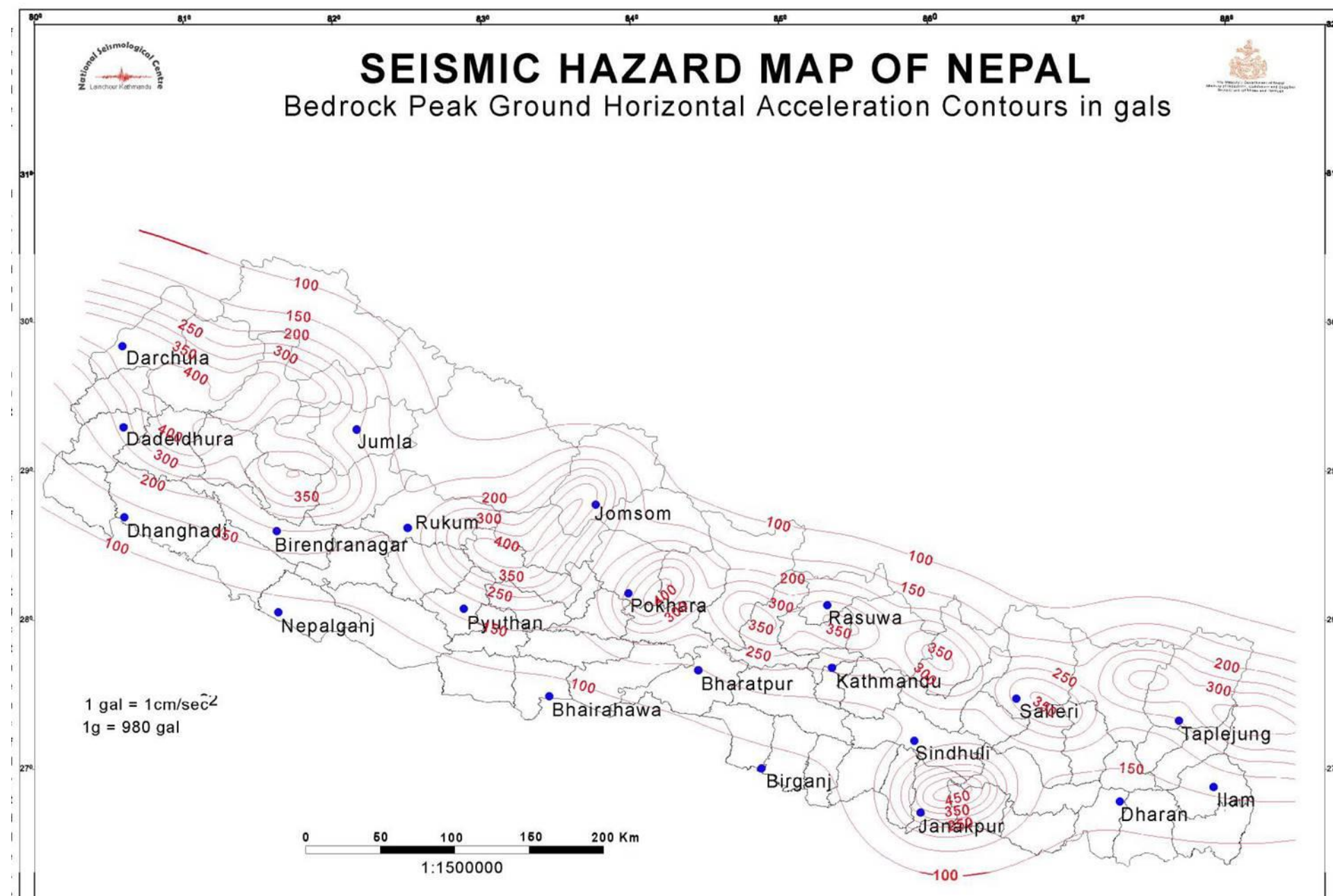


Fig. 8: Probabilistic Seismic Hazard Assessment Map of the Nepal Himalaya

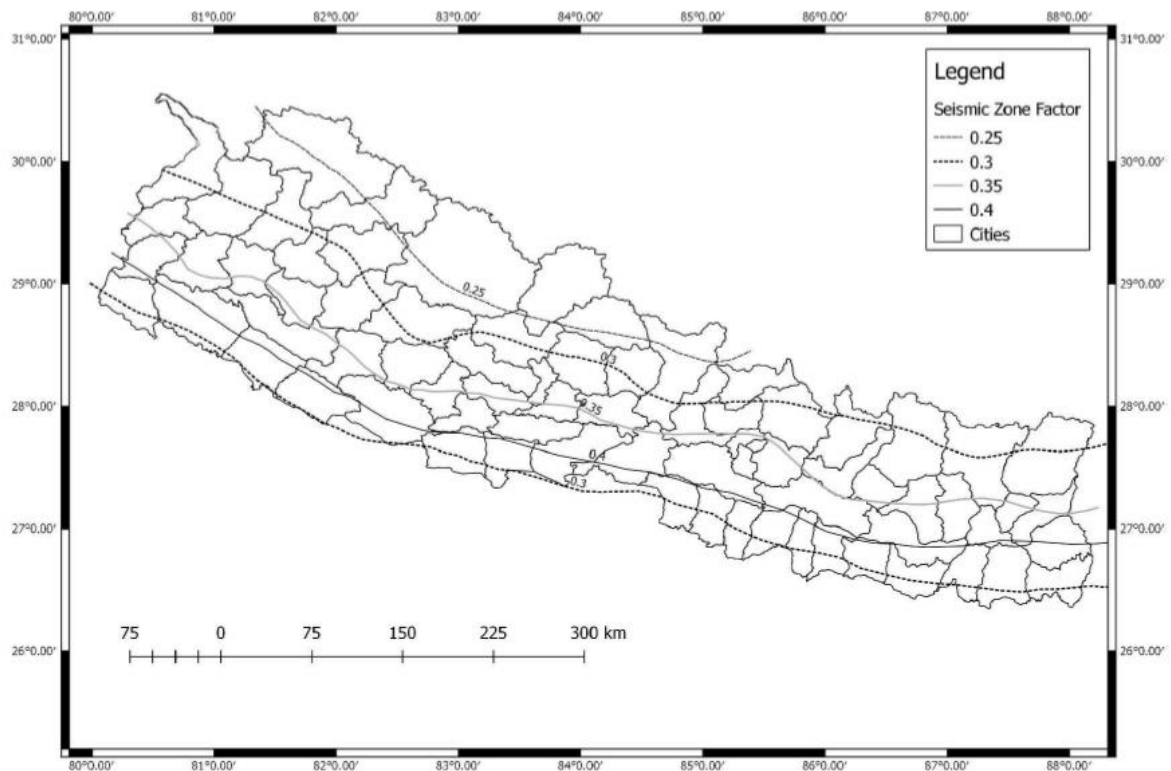


Fig 9: Seismic Zone Factor, Z (From Seismic Zoning Map of Nepal)

To counteract earthquake effect, due consideration has to be taken in the structural design of structures as per seismic design as provided by Building Code of Nepal. The project area is located in the area having Seismic Zone Factor, Z, equal to 0.3 (Pokhara area) and 0.35 (Damauli area) according to Seismic Zoning Map of Nepal in Nepal National Building Code NBC: 105: 2020.

8. Liquefaction

Saturated loose to medium dense cohesion less soils and low plastic silts tend to densify and consolidate when subjected to cyclic shear deformations inherent with large seismic ground motions. Pore-water pressures within such layers increase as the soils are cyclically loaded, resulting in a decrease in vertical effective stress and shear strength. If the shear strength drops below the applied cyclic shear loadings, the layer is expected to transition to a semi fluid state until the excess pore-water pressure dissipates.

8.1 Identification of liquefaction area

The present site consists of various soil types as mentioned in borehole logs and water table

depth encountered in them. All the borehole is assumed to have water table at surface and some of major soil type is adopted to be medium sand to depict the worst-case scenario for liquefaction analysis.

8.2 Analysis of Liquefaction

In general, for clean sand, if the SPT value is less than 30, the soil is prone to liquefaction. The increase in fines content, however, increases the liquefaction resistance of soil. Here, in our analysis, increase in fine content from 35% and greater is considered to be no liquefaction strata. In this report, the soil liquefaction analysis has been done based on SPT N value.

The factor of safety (FS) against liquefaction in terms of CSR (Cyclic stress ratio) and CRR (cyclic resistance ratio) is defined by

$$FS = \frac{CRR_{7.5}}{CSR_{7.5,\sigma}}$$

Where, $CRR_{7.5}$ is the cyclic stress ratio (CRR) for earthquakes of magnitude 7.5 and

$CSR_{7.5,\sigma}$ is the normalized cyclic stress ratio (CSR) for earthquakes of magnitude 7.5 and effective overburden pressure of 100 kPa.

$CSR_{7.5,\sigma}$ Is given by (Idriss and Boulanger, 2006)

$$CSR_{7.5,\sigma} = 0.65 \frac{\sigma_v}{\sigma'_v} \frac{a_{\max}}{g} \frac{\gamma_d}{MSF} \frac{1}{K_\sigma}$$

σ_v is the total vertical stress; σ'_v is the effective vertical stress; $a_{\max}$ is the peak horizontal ground surface acceleration; g is the acceleration of gravity; γ_d is the nonlinear shear stress mass participation factor (or stress reduction factor), MSF is the magnitude scaling factor; K_σ is the correction factor for effective overburden. The consideration of factors K_σ and K_a (for sloping ground) is beyond routine practice and can be precisely estimated using the method of Youd et al. (2001) if necessary.

The term γ_d provides an approximate correction for flexibility in the soil profile given by:

$$\gamma_d = \frac{(1 - 0.4113z^{0.5} + 0.04052z + 0.001753z^{1.5})}{(1 - 0.4177z^{0.5} + 0.05729z - 0.006205z^{1.5} + 0.00121z^2)}$$

Where, z = depth below ground surface in meters.

Cyclic resistance ratio (CRR), the capacity of soil to resist liquefaction, can be obtained from the corrected blow count $(N_1)_{60}$ using empirical correlations proposed by Seed et al. (1985).

The CRR curves for a fines content of < 5% (clean sands) can be approximated by Youd et al. (2001)

$$CRR_{7.5} = \frac{1}{34 - (N_1)_{60}} + \frac{(N_1)_{60}}{135} + \frac{50}{[10.(N_1)_{60} + 45]^2} - \frac{1}{200}$$

For $(N_1)_{60} < 30$. For $(N_1)_{60} \geq 30$, clean granular soils are classified as non-liquefiable. The CRR increases with increasing fines content and thus $(N_1)_{60}$ should be corrected to an equivalent clean sand value, $(N_1)_{60CS}$ (Youd et al. 2001)

$$(N_1)_{60CS} = (N_1)_{60}; FC \leq 5\%$$

$$(N_1)_{60CS} = \exp[1.76 - (190 / FC^2)] + [0.99 + (FC^{1.5} / 1000)](N_1)_{60}; 5\% \leq FC \leq 35\%$$

$$(N_1)_{60CS} = 5 + 1.2(N_1)_{60}; FC \geq 35\%$$

Where $(N_1)_{60}$ is the SPT blow count normalized to an overburden pressure of approximately 100 kPa and a hammer energy ratio of 60% expressed as (Youd et al. 2001)

$$(N_1)_{60} = NC_N C_E C_B C_R C_S$$

Where N = measured standard penetration resistance; C_N = factor to normalize N to a common reference effective overburden stress (1 atm.); C_E = correction for hammer energy ratio; C_B = correction factor for borehole diameter; C_R = correction factor for rod length; C_S = correction for samplers with or without liners. The factor C_N is given by

$$C_N = \frac{2.2}{1.2 + \sigma'_v / P_a}$$

Following the recommendation of NCEER 1996 (Youd et al. 2001), the lower and upper bounds for MSF values can be defined by $MSF = 10^{2.24 / M_w^{2.56}}$ and $MSF = (M_w / 7.5)^{-3.3}$, respectively (M_w is the moment magnitude). Similarly, K_σ is given by (Youd et al., 2001)

$$K_\sigma = (\sigma'_v / P_a)^{(f-1)}$$

Where P_a is the atmospheric pressure (100 kPa) and f is assumed to be 0.75 (a value of 0.6-0.8 is recommended in Youd et al., 2001).

Iwasaki (1982) was used to calculate Liquefaction Potential Index (L.P.I) and to calculate the severity of site towards liquefaction.

According to Iwasaki;

Iwasaki et. Al. (1982)	
Liquefaction Potential Index, (LPI)	Severity
0	Very Low
$0 < LPI < 5$	Low
$5 < LPI < 15$	High
$15 < LPI$	Very High

Literatures Reviewed:

After recent review of various research papers from various country and various soil condition. The following assumption is taken in consideration either the Soil is Susceptible to liquefaction or not:

- Clayey layer with fines greater than 35% with Liquid Limit greater than 35, having Plasticity Index greater than 12 and moisture content lower than 85% of Liquid limit isn't susceptible towards liquefaction.
- Soil having natural moisture nearly equal to Liquid Limit may experience behavior similar to liquefaction so proper mechanism should be designed to encounter the situation.
- If the Plasticity Index (PI) of the soil is equal or greater than 7 than such soil layer isn't susceptible to liquefaction. (Boulanger and Idriss, 2006)
- Soil with $PI < 12$ and ratio of Water Content to Liquid Limit (Wc/LL) > 0.85 will be susceptible to liquefaction. (Bray and Sancio, 2006)

Table 5: Sample Procedures for Analysis and Result Interpretations of Liquefaction

Deterministic Approach For Liquefaction Analysis- NCEER- 1996/1998
Geotechnical Investigation of Proposed sites of Substations and Transmission Lines

BORE HOLE NO: 1

LOCATION : Kaski

G.W.L (Z_w) : 0.00

a_{max}/g : 0.3

Moment magnitude (M): 7.80

MSF: 0.89

FoS against Liquefaction : 1

Atmospheric Pressure(P_a) = 100 Kpa
f= 0.75

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	K _σ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	0.00	Very Low
2	1.5	23	Medium Sand	53.36		17	26	11	1.68	38.69	51.43	30.00	0.990	1.745	0.468	0.294	1.59	No	0	9.25	1.5	0.00		
3	3.0	28	Medium Sand	32.41		17	51	22	1.55	43.51	55.96	30.00	0.979	1.467	0.468	0.345	1.35	No	0	8.5	1.5	0.00		
4	4.5	31	Medium Sand	34.12		17	77	32	1.44	44.76	58.17	30.00	0.969	1.326	0.468	0.378	1.24	No	0	7.75	1.5	0.00		
5	6.0	41	Medium Sand	17.47		17	102	43	1.35	55.29	61.89	30.00	0.958	1.234	0.468	0.401	1.16	No	0	7	1.5	0.00		

BORE HOLE NO: 2

LOCATION : Kaski

G.W.L (Z_w) : 0.00

a_{max}/g : 0.3

Moment magnitude (M): 7.80

MSF: 0.89

FoS against Liquefaction : 1

Atmospheric Pressure(P_a) = 100 Kpa
f= 0.75

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	K _σ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	0.00	Very Low
2	1.5	35	Medium Sand	5.00		17	26	11	1.68	58.88	58.88	30.00	0.990	1.745	0.468	0.294	1.59	No	0	9.25	1.5	0.00		

BORE HOLE NO: 3
LOCATION : Tanahun
G.W.L (Z_w) : 20.00 Not available
a_{max}/g : 0.3
Moment magnitude (M): 7.80
MSF: 0.89
FoS against Liquefaction : 1

Atmospheric Pressure(P_a) = 100 Kpa
 f= 0.75

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	Kσ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	0.00	Very Low
2	1.5	7	Medium Sand	53.24		17	26	26	1.51	10.58	17.70	17.70	0.990	1.407	0.188	0.154	-	No	0	9.25	1.5	0.00		
3	3.0	8	Medium Sand	57.90		17	51	51	1.29	10.29	17.35	17.35	0.979	1.183	0.185	0.181	-	No	0	8.5	1.5	0.00		
4	4.5	9	Medium Sand	57.90		17	77	77	1.12	10.08	17.09	17.09	0.969	1.069	0.182	0.198	-	No	0	7.75	1.5	0.00		
5	6.0	44	Medium Sand	63.70		17	102	102	0.99	43.60	57.32	30.00	0.958	0.995	0.468	0.211	-	No	0	7	1.5	0.00		

BORE HOLE NO: 4
LOCATION : Sishaghat
G.W.L (Z_w) : 0.00
a_{max}/g : 0.3
Moment magnitude (M): 7.80
MSF: 0.89
FoS against Liquefaction : 1

Atmospheric Pressure(P_a) = 100 Kpa
 f= 0.75

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	Kσ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	0.00	Very Low
2	1.5	32	Medium Sand	29.15		17	26	11	1.68	53.83	66.41	30.00	0.990	1.745	0.468	0.294	1.59	No	0	9.25	1.5	0.00		
3	3.0	39	Medium Sand	14.24		17	51	22	1.55	60.61	65.53	30.00	0.979	1.467	0.468	0.345	1.35	No	0	8.5	1.5	0.00		
4	4.5	39	Medium Sand	27.25		17	77	32	1.44	56.32	68.26	30.00	0.969	1.326	0.468	0.378	1.24	No	0	7.75	1.5	0.00		
5	6.0	44	Medium Sand	32.82		17	102	43	1.35	59.34	74.77	30.00	0.958	1.234	0.468	0.401	1.16	No	0	7	1.5	0.00		

BORE HOLE NO: 5
LOCATION : Ranibari, Tanahun
G.W.L (Z_w) : 0.00
a_{max}/g : 0.3
Moment magnitude (M): 7.80
MSF: 0.89
FoS against Liquefaction : 1

Atmospheric Pressure(P_a) = 100 Kpa
 f= 0.75

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	K _σ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	0.00	Very Low
2	1.5	13	Medium Sand	81.50		17	26	11	1.68	21.87	31.24	30.00	0.990	1.745	0.468	0.294	1.59	No	0	9.25	1.5	0.00		
3	3.0	17	Medium Sand	86.32		17	51	22	1.55	26.42	36.70	30.00	0.979	1.467	0.468	0.345	1.35	No	0	8.5	1.5	0.00		
4	4.5	20	Medium Sand	84.16		17	77	32	1.44	28.88	39.66	30.00	0.969	1.326	0.468	0.378	1.24	No	0	7.75	1.5	0.00		
5	6.0	24	Medium Sand	78.58		17	102	43	1.35	32.36	43.84	30.00	0.958	1.234	0.468	0.401	1.16	No	0	7	1.5	0.00		

BORE HOLE NO: 6
LOCATION : Damauli
G.W.L (Z_w) : 0.00
a_{max}/g : 0.3
Moment magnitude (M): 7.80
MSF: 0.89
FoS against Liquefaction : 1

Atmospheric Pressure(P_a) = 100 Kpa
 f= 0.75

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	K _σ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	0.00	Very Low
2	1.5	50	Medium Sand	5.00		19.05	29	14	1.64	82.18	82.18	30.00	0.990	1.639	0.468	0.273	1.72	No	0	9.25	1.5	0.00		

BORE HOLE NO: 7

LOCATION : Damauli

G.W.L (Z_w) : 0.00

a_{max}/g : 0.3

Moment magnitude (M): 7.80

MSF: 0.89

FoS against Liquefaction : 1

Atmospheric Pressure(P_a) = 100 Kpa

f= 0.75

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	K _σ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	0.00	Very Low
2	1.5	12	Medium Sand	69.91		17	26	11	1.68	20.19	29.22	29.22	0.990	1.745	0.421	0.294	1.43	No	0	9.25	1.5	0.00		
3	3.0	28	Medium Sand	63.00		17	51	22	1.55	43.51	57.21	30.00	0.979	1.467	0.468	0.345	1.35	No	0	8.5	1.5	0.00		
4	4.5	28	Medium Sand	53.64		17	77	32	1.44	40.43	53.52	30.00	0.969	1.326	0.468	0.378	1.24	No	0	7.75	1.5	0.00		
5	6.0	31	Medium Sand	45.35		17	102	43	1.35	41.80	55.17	30.00	0.958	1.234	0.468	0.401	1.16	No	0	7	1.5	0.00		

BORE HOLE NO: 8

LOCATION : DAMAULI SUBSTATION

G.W.L (Z_w) : 0.00

a_{max}/g : 0.3

Moment magnitude (M): 7.80

MSF: 0.89

FoS against Liquefaction : 1

Atmospheric Pressure(P_a) = 100 Kpa

f= 0.75

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	K _σ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	7.64	High
2	1.5	11	Medium Sand	35.31		17	26	11	1.68	18.50	27.20	27.20	0.990	1.745	0.344	0.294	1.17	No	0	9.25	1.5	0.00		
3	3.0	15	Medium Sand	3.39		17	51	22	1.55	23.31	23.31	23.31	0.979	1.467	0.262	0.345	0.76	Yes	0.24	8.5	1.5	3.06		
4	4.5	13	Medium Sand	49.81		17	77	32	1.44	18.77	27.53	27.53	0.969	1.326	0.354	0.378	0.94	Yes	0.06	7.75	1.5	0.70		
0	6.0	15	Medium Sand	12.50		17	102	43	1.35	20.23	22.64	22.64	0.958	1.234	0.251	0.401	0.63	Yes	0.37	7	1.5	3.89		
0	7.5	21	Medium Sand	26.27		17	128	54	1.26	26.56	34.29	30.00	0.943	1.167	0.468	0.418	1.12	No	0	6.25	1.5	0.00		
0	9.0	31	Medium Sand	18.54		17	153	65	1.19	36.92	42.85	30.00	0.923	1.115	0.468	0.428	1.09	No	0	5.5	1.5	0.00		
0	10.5	30	Medium Sand	7.43		17	179	75	1.13	33.76	34.29	30.00	0.894	1.073	0.468	0.431	1.08	No	0	4.75	1.5	0.00		
9	12.0	32	Medium Sand	31.89		17	204	86	1.07	34.13	44.76	30.00	0.857	1.038	0.468	0.427	1.10	No	0	4	1.5	0.00		
10	13.5	46	Medium Sand	5.00		17	230	97	1.01	46.62	46.62	30.00	0.811	1.007	0.468	0.416	1.12	No	0	3.25	1.5	0.00		
11	15.0	46	Medium Sand	5.00		17	255	108	0.97	44.42	44.42	30.00	0.761	0.981	0.468	0.401	1.17	No	0	2.5	1.5	0.00		

BORE HOLE NO: 9

LOCATION : Lekhnath Substation

G.W.L (Z_w) : 0.00

a_{max}/g : 0.3

Moment magnitude (M): 7.80

MSF: 0.89

FoS against Liquefaction : 1

Atmospheric Pressure(P_a) = 100 Kpa

f= 0.75

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	K _σ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	0.00	Very Low
2	1.5	35	Medium Sand	11.22		17	26	11	1.68	58.88	61.78	30.00	0.990	1.745	0.468	0.294	1.59	No	0	9.25	1.5	0.00		
3	3.0	39	Medium Sand	11.22		17	51	22	1.55	60.61	63.56	30.00	0.979	1.467	0.468	0.345	1.35	No	0	8.5	1.5	0.00		
4	4.5	39	Medium Sand	1.91		17	77	32	1.44	56.32	56.32	30.00	0.969	1.326	0.468	0.378	1.24	No	0	7.75	1.5	0.00		
5	6.0	44	Medium Sand	1.91		17	102	43	1.35	59.34	59.34	30.00	0.958	1.234	0.468	0.401	1.16	No	0	7	1.5	0.00		
6	7.5	44	Medium Sand	5.51		17	128	54	1.26	55.66	55.83	30.00	0.943	1.167	0.468	0.418	1.12	No	0	6.25	1.5	0.00		
7	9.0	46	Medium Sand	5.51		17	153	65	1.19	54.79	54.96	30.00	0.923	1.115	0.468	0.428	1.09	No	0	5.5	1.5	0.00		
8	10.5	46	Medium Sand	5.51		17	179	75	1.13	51.77	51.93	30.00	0.894	1.073	0.468	0.431	1.08	No	0	4.75	1.5	0.00		
9	12.0	46	Medium Sand	6.10		17	204	86	1.07	49.06	49.34	30.00	0.857	1.038	0.468	0.427	1.10	No	0	4	1.5	0.00		
10	13.5	46	Medium Sand	6.10		17	230	97	1.01	46.62	46.89	30.00	0.811	1.007	0.468	0.416	1.12	No	0	3.25	1.5	0.00		
11	15.0	46	Medium Sand	6.10		17	255	108	0.97	44.42	44.68	30.00	0.761	0.981	0.468	0.401	1.17	No	0	2.5	1.5	0.00		

BORE HOLE NO: 1 - NEW
LOCATION : DAMAULI SUBSTATION
G.W.L (Z_w) : 0.00
a_{max}/g : 0.35
Moment magnitude (M): 7.80
MSF: 0.89
FoS against Liquefaction : 1

Atmospheric Pressure(P_a) = 100 Kpa
 f= 0.75

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	K _σ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki ,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	24.47	Very High
2	1.5	15	Medium Sand	5.85		17	26	11	1.68	25.23	25.36	25.36	0.990	1.745	0.299	0.343	0.87	Yes	0.13	9.25	1.5	1.80		
3	3.0	11	Medium Sand	5.28		17	51	22	1.55	17.09	17.14	17.14	0.979	1.467	0.182	0.403	0.45	Yes	0.55	8.5	1.5	7.01		
4	4.5	17	Medium Sand	9.20		17	77	32	1.44	24.55	25.60	25.60	0.969	1.326	0.304	0.441	0.69	Yes	0.31	7.75	1.5	3.60		
5	6.0	10	Medium Sand	28.69		17	102	43	1.35	13.49	20.04	20.04	0.958	1.234	0.216	0.468	0.46	Yes	0.54	7	1.5	5.67		
6	7.5	7	Medium Sand	28.69		17	128	54	1.26	8.85	14.74	14.74	0.943	1.167	0.157	0.488	0.32	Yes	0.68	6.25	1.5	6.38		
7	9.0	34	Gravel	3.69		17	153	65	1.19	40.50	40.50	30.00	0.923	1.115	0.468	0.500	0.94	No	0	5.5	1.5	0.00		
8	10.5	46	Gravel	23.04		17	179	75	1.13	51.77	61.04	30.00	0.894	1.073	0.468	0.503	0.93	No	0	4.75	1.5	0.00		
9	12.0	46	Gravel	27.78		17	204	86	1.07	49.06	60.30	30.00	0.857	1.038	0.468	0.498	0.94	No	0	4	1.5	0.00		
10	13.5	46	Gravel	30.22		17	230	97	1.01	46.62	58.62	30.00	0.811	1.007	0.468	0.486	0.96	No	0	3.25	1.5	0.00		
11	15.0	46	Gravel	46.69		17	255	108	0.97	44.42	58.30	30.00	0.761	0.981	0.468	0.468	1.00	No	0	2.5	1.5	0.00		

BORE HOLE NO: 2 - NEW

LOCATION : Lekhnath Substation

G.W.L (Z_w) : 0.00

a_{max}/g : 0.35

Moment magnitude (M): 7.80

MSF: 0.89

FoS against Liquefaction : 1

Atmospheric Pressure(P_a) = 100 Kpa

f= 0.75

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	K _σ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki ,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	6.58	High
2	1.5	35	Medium Sand	27.25		17	26	11	1.68	58.88	71.16	30.00	0.990	1.745	0.468	0.343	1.37	No	0	9.25	1.5	0.00		
3	3.0	17	Medium Sand	35.07		17	51	22	1.55	26.42	36.70	30.00	0.979	1.467	0.468	0.403	1.16	No	0	8.5	1.5	0.00		
4	4.5	39	Medium Sand	19.19		17	77	32	1.44	56.32	63.96	30.00	0.969	1.326	0.468	0.441	1.06	No	0	7.75	1.5	0.00		
5	6.0	23	Medium Sand	25.49		17	102	43	1.35	31.02	39.04	30.00	0.958	1.234	0.468	0.468	1.00	Yes	0	7	1.5	0.00		
6	7.5	16	Medium Sand	35.77		17	128	54	1.26	20.24	29.29	29.29	0.943	1.167	0.425	0.488	0.87	Yes	0.13	6.25	1.5	1.22		
7	9.0	9	Medium Sand	27.46		17	153	65	1.19	10.72	16.67	16.67	0.923	1.115	0.177	0.500	0.35	Yes	0.65	5.5	1.5	5.36		
8	10.5	46	Gravel	11.44		17	179	75	1.13	51.77	54.61	30.00	0.894	1.073	0.468	0.503	0.93	No	0	4.75	1.5	0.00		
9	12.0	46	Gravel	11.44		17	204	86	1.07	49.06	51.83	30.00	0.857	1.038	0.468	0.498	0.94	No	0	4	1.5	0.00		
10	13.5	46	Gravel	11.44		17	230	97	1.01	46.62	49.32	30.00	0.811	1.007	0.468	0.486	0.96	No	0	3.25	1.5	0.00		
11	15.0	46	Gravel	11.44		17	255	108	0.97	44.42	47.05	30.00	0.761	0.981	0.468	0.468	1.00	No	0	2.5	1.5	0.00		

BORE HOLE NO: 3 - NEW

LOCATION : Lekhnath Substation

G.W.L (Z_w) : 0.00

a_{max}/g : 0.35

Moment magnitude (M): 7.80

MSF: 0.89

Atmospheric Pressure(P_a) = 100 Kpa

f= 0.75

FoS against Liquefaction : 1

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	K _σ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki ,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	17.16	Very High
2	1.5	12	Medium Sand	35.90		17	26	11	1.68	20.19	29.22	29.22	0.990	1.745	0.421	0.343	1.23	No	0	9.25	1.5	0.00		
3	3.0	19	Medium Sand	4.13		17	51	22	1.55	29.53	29.53	29.53	0.979	1.467	0.438	0.403	1.09	No	0	8.5	1.5	0.00		
4	4.5	16	Medium Sand	11.91		17	77	32	1.44	23.10	25.35	25.35	0.969	1.326	0.299	0.441	0.68	Yes	0.32	7.75	1.5	3.72		
5	6.0	9	Medium Sand	25.10		17	102	43	1.35	12.14	17.84	17.84	0.958	1.234	0.190	0.468	0.41	Yes	0.59	7	1.5	6.20		
6	7.5	5	Silt	55.98		17	128	54	1.26	6.32	12.59	12.59	0.943	1.167	0.137	0.488	0.28	Yes	0.72	6.25	1.5	6.75		
7	9.0	45	Medium Sand	2.07		17	153	65	1.19	53.60	53.60	30.00	0.923	1.115	0.468	0.500	0.94	Yes	0.06	5.5	1.5	0.50		
8	10.5	46	Gravel	13.68		17	179	75	1.13	51.77	55.97	30.00	0.894	1.073	0.468	0.503	0.93	No	0	4.75	1.5	0.00		
9	12.0	46	Gravel	13.68		17	204	86	1.07	49.06	53.16	30.00	0.857	1.038	0.468	0.498	0.94	No	0	4	1.5	0.00		
10	13.5	46	Gravel	13.68		17	230	97	1.01	46.62	50.62	30.00	0.811	1.007	0.468	0.486	0.96	No	0	3.25	1.5	0.00		
11	15.0	46	Gravel	13.68		17	255	108	0.97	44.42	48.32	30.00	0.761	0.981	0.468	0.468	1.00	No	0	2.5	1.5	0.00		

BORE HOLE NO: 4 - NEW

LOCATION : Lekhnath Substation

G.W.L (Z_w) : 0.00

a_{max}/g : 0.35

Moment magnitude (M): 7.80

MSF: 0.89

Atmospheric Pressure(P_a) = 100 Kpa

f= 0.75

FoS against Liquefaction : 1

S.N.	Depth (m)	Corrected SPT (N ₆₀)	Major Soil type	Fine contents %	PI	Unit wt (KN/m ³)	Total Stress (KN/m ²)	Eff stress (KN/m ²)	C _N	(N ₁) ₆₀	(N ₁) _{60cs}	(N ₁) _{60cs}	γ _d	K _σ	CRR	CSR _{M,σ}	FS	Liquefaction	F(z)	w(z)	H	F(z).w(z).H	Liquefaction Potential Index	Severity (Iwasaki ,1982)
1	0.0						0		1.70				1.000						0	10	1.5	0.00	12.61	High
2	1.5	35	Medium Sand	8.38		17	26	11	1.68	58.88	60.10	30.00	0.990	1.745	0.468	0.343	1.37	No	0	9.25	1.5	0.00		
3	3.0	9	Medium Sand	49.92		17	51	22	1.55	13.99	21.78	21.78	0.979	1.467	0.239	0.403	0.59	Yes	0.41	8.5	1.5	5.23		
4	4.5	13	Medium Sand	30.04		17	77	32	1.44	18.77	26.38	26.38	0.969	1.326	0.322	0.441	0.73	Yes	0.27	7.75	1.5	3.14		
5	6.0	18	Medium Sand	35.92		17	102	43	1.35	24.27	34.13	30.00	0.958	1.234	0.468	0.468	1.00	Yes	0	7	1.5	0.00		
6	7.5	16	Medium Sand	18.90		17	128	54	1.26	20.24	25.11	25.11	0.943	1.167	0.294	0.488	0.60	Yes	0.4	6.25	1.5	3.75		
7	9.0	46	Medium Sand	13.12		17	153	65	1.19	54.79	58.77	30.00	0.923	1.115	0.468	0.500	0.94	Yes	0.06	5.5	1.5	0.50		
8	10.5	46	Gravel	9.70		17	179	75	1.13	51.77	53.58	30.00	0.894	1.073	0.468	0.503	0.93	No	0	4.75	1.5	0.00		
9	12.0	46	Gravel	14.94		17	204	86	1.07	49.06	53.88	30.00	0.857	1.038	0.468	0.498	0.94	No	0	4	1.5	0.00		
10	13.5	46	Gravel	9.70		17	230	97	1.01	46.62	48.34	30.00	0.811	1.007	0.468	0.486	0.96	No	0	3.25	1.5	0.00		
11	15.0	46	Gravel	9.70		17	255	108	0.97	44.42	46.08	30.00	0.761	0.981	0.468	0.468	1.00	No	0	2.5	1.5	0.00		

8.3 Conclusion and Recommendation

- The liquefiable depths with liquefaction potential index and their severity at different borehole locations for considered parameters according to our analysis is tabulated below.

Summary of Liquefaction Analysis for PGA/g=0.3 for Kaski and Tanahun Districts from NBC 105:2020 and Mw=7.8 (Gorkha Earthquake)			
Borehole No.	Depths (m) Having Factor of Safety < 1	Liquefaction Potential Index	Severity
BOREHOLE 1	-	0.00	Very Low
BOREHOLE 2	-	0.00	Very Low
BOREHOLE 3	-	0.00	Very Low
BOREHOLE 4	-	0.00	Very Low
BOREHOLE 5	-	0.00	Very Low
BOREHOLE 6	-	0.00	Very Low
BOREHOLE 7	-	0.00	Very Low
BOREHOLE 8	3-6	7.64	High
BOREHOLE 9	-	0.00	Very Low

Summary of Liquefaction Analysis for PGA/g=0.35 for Damauli Area from NBC 105:2020 and Mw=7.8 (Gorkha Earthquake)				
NEW BOREHOLES OF DAMAULI SUBSTATION				
Borehole No.	Depths (m) Having Factor of Safety < 1	Liquefaction Potential Index	Severity	Proposed Foundation Type
BOREHOLE 1 - NEW	1.5-7.5	24.47	Very High	Pile Foundation
BOREHOLE 2 - NEW	6-9	6.58	High	Pile Foundation
BOREHOLE 3 - NEW	4.5-9	17.16	Very High	Pile Foundation
BOREHOLE 4 - NEW	3-9	12.61	High	Pile Foundation

- The site is susceptible to liquefaction in Borehole 1-4 (New) and Borehole 8 at the time of worst-case scenario.
- Considering possibility of liquefaction under adopted parameters in New boreholes 1 to 4 and Borehole 8 i.e. at location of Damauli Substation, it is recommended to place either raft foundation or extend cast in-situ bored pile significantly below liquefiable

depth from generalized ground level.

- It is recommended to place the pile foundation in the i.e. in the bearing stratum i.e. depth around 10 m of the project site so as to get the maximum tip resistance.
- Modern techniques like sand compaction piles, densification, and water-replacement, deep mixing can prevent area from liquefaction as per availability in the market.

9. Analysis of Allowable Bearing Pressure

The allowable bearing pressure (q_a) is the maximum pressure that can be imposed on the foundation soil taking into consideration the ultimate bearing capacity of the soil and the tolerable settlement of the structure. Analysis to determine the ultimate bearing capacity and the pressure corresponding to a specified maximum settlement were performed and the minimum pressure obtained from the two analyses were adopted as the allowable bearing pressure. Here, isolated, raft and pile foundations for different depths and dimensions are analyzed for the case of static condition considering the worst condition i.e., submerged condition.

9.1 SPT correction

The so obtained SPT values have been corrected in accordance with the proposal of Skempton, (1986) and Liao and Whitman (1987) as outlined below with consideration of field procedure, hammer efficiency, borehole diameter, and sample and rod length.

Correction of SPT N-value using the relation after Skempton, 1986

$$N_{60} = E_m C_B C_S C_R N / 0.60$$

Where: N_{60} = SPT N value corrected for field procedure

E_m = Hammer Efficiency, C_B = borehole diameter correction, C_S = Sample Correction, C_R = rod length correction, N = SPT N value recorded in the field,

The correction factors taken are:

$E_m = 0.55$ for hand drop hammer, due to lack of true verticalness and proper speed of SPT blow

$C_B = 1.0$ for 65 mm to 115 mm dia. Borehole,

$C_s = 1.0$ for standard sampler,

$C_R = 0.7$ for rod length 0.00 - 2.99,

$= 0.75$ for rod length 3.00 - 3.99 m,

=0.85 for rod length 4.00 - 5.99 m,

=0.95 for rod length 6.00 - 9.99 m,

=1 for rod length beyond 10.00 m,

Correction for overburden

The correction for values of N should be made for the field SPT values for depths. Modified correction in 1974, peck, Hanson and Thornburn suggested standard pressure of 100 kN/m² corresponding to a depth of 5 m of soil with bulk density 20kN/m² can be represented by the following equation:

$$(N_1)_{60} = N_{60} C_n$$

$$C_n = 0.77 \log (2000/p_0)$$

Where, p_0 is effective overburden pressure in kN/m².

Dilatancy Correction (for fine sand and silts below water table)

Terzaghi and Peak (1976) give correction for water pressure.

If, $N_{rec} \leq 15$, then $N_{corr} = N_{rec}$

If $N_{rec} \geq 15$, then $N_{corr} = 15 + 1/2(N_{rec} - 15)$

Then for bearing capacity analysis N_{corr} is used as the N in the Correlation provided by different Researchers.

9.2 Allowable Bearing Capacity from Shear Failure Criteria

The bearing capacity analysis has been carried out for foundation soil. The bearing capacity analysis was carried out based on the results of SPT N-value. The so adopted N-value is the average value beneath each point between level of the base of the footing and the depth equal to 2 times the width of the foundation. In computing the average any individual value more than 50 percent greater than the average was neglected, but the values for all loose seams if encountered was included. (IS 6403:1981)

The well-known Indian Standard (IS 6403:1981) has been used to compute bearing capacity of soil on the basis of shear failure criteria. Different depths and widths of foundation are used in the analysis.

Indian Standard IS 6403:1981

$$q_{na} = (c N_c s_c d_c i_c + q (N_q - 1) s_q d_q i_q + 0.5 B \gamma N_\gamma s_\gamma d_\gamma i_\gamma) / FOS$$

Where,

Df = Depth of foundation

FOS = Factor of safety

C = cohesion in KN/m²

N_c, N_q, N_γ = Bearing capacity factors

$$N_q = \pi \gamma B \tan \phi \tan^2 \left(45 + \frac{\phi}{2} \right)$$

$$N_c = (N_q - 1) \cot \phi$$

$$N_\gamma = 2 (N_q + 1) \tan \phi$$

s_c, s_q, s_γ = Shape factors

d_c, d_q, d_γ = Depths factors

i_c, i_q, i_γ = Inclination factors

q = Effective surcharge at the base level of foundation in KN/m²

B = Width of footing in, m

γ = Bulk unit weight of soil sample in KN/m³

R_w = Correction factor for location of water table

9.3 Allowable Bearing Pressure from Settlement Criteria in Granular soils

The following equation is used to determine bearing capacity from settlement criteria for S mm settlement by Bowle's equation.

$$q_{np} = 12.2 N \left(\frac{B+0.3}{B} \right)^2 R_d W_\gamma (S/25)$$

Where,

B = Width of foundation

W_γ and W_q are water table correction factor

D_f = Depth of foundation

N_c = SPT Value corrected for overburden pressure

q_{np} = safe settlement pressure

9.4 Allowable Bearing Pressure based on Tolerable Settlement in Cohesive Soils

If the clay layer is encountered, the settlement was calculated by:

$$S_f = H_t / (1 + e_0) * C_c \log_{10} ((p_0 + \Delta p) / p_0)$$

Where: S_f = Consolidation or settlement in m

H_t = Thickness of soil layer in m

e⁰ = Initial void ratio

P_0 = Effective stress at mid height of layer in kN/m^2

Δp = Pressure increment kN/m^2

The minimum of allowable bearing capacity value obtained from the shear failure criteria and settlement criteria is adopted as the allowable bearing capacity for the given foundation size at that depth.

10. Pile Foundation

The bearing capacity of pile foundation is based on Indian Standard code. The following methodologies were used.

$$Q_{u1} = A_p \left(\frac{1}{2} D_r N_r + P_D N_q \right) + \sum_{i=1}^n K P_{Di} \tan \delta \cdot A_{si}$$

$$Q_{u2} = A_p C N_c + \alpha c \cdot A_{si}$$

$$Q_u = Q_{u1} + Q_{u2}$$

Where

A_p = Cross sectional area of pile toe

D = Stem diameter

γ = effective unit weight of soil at pile toe

P_D = effective over burden pressure at pile toe

N_r & N_q = bearing capacity factor depending upon the angle of internal friction at toe.

$\sum_{i=1}^n$ = summation of n layers in which pile is installed.

ϕ = angle of internal friction

K = coefficient of earth pressure $\left(= \frac{1 - \sin \phi}{1 + \sin \phi} \right)$

P_{di} = effective over burden pressure for the i^{th} layer where i varies from 1 to n.

δ = angle of wall friction between the pile

A_{si} = surface area of pile stem in the i^{th} layer

C = Cohesion of Soil

N_c = Skempton factor

α = Adhesion Factor

The minimum factor of safety for arriving at the safe pile capacity from the ultimate load

capacity obtained by using static formulae shall be 2.5.

The bearing capacity of a single pile is to be determined from **Pile Load Test**. The purpose of the test is one or more of the following:

- to establish criteria for installation of working piles
- to establish settlement of working load
- to get an idea of the suitability of the pile for a purpose
- to determine the safe load capacity

Some Assumptions for Analysis

- Due to limitation of drilled depth, it is assumed that the soil strata are similar underneath as like the preceding last drilled depth for settlement analysis of foundation of sizes where 2B exceeds the borehole depth.
- In between two tested samples, properties of soil in middle sections were interpolated as relevancy of data. And design data were interpolated between semi empirical data from field test and lab test results.

11.Recommendation of Foundation Type and Depth

Based on the analysis, the following recommendations are made.

- Isolated and Raf/Mat footing are analyzed for allowable bearing capacity (static condition) for permissible settlement of 25 mm and 40 mm respectively. The details with different depths and different dimensions of Isolated and Raft/Mat footing of the project site at different borehole locations is summarized below:

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 1																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 20 mm Permissible Settlement	201	216	216	207	194	186	179	256	243	229	219	204	193	186	270	248	240	235	217	205	196	275	252	245	239	231	217	207

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 1																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 25 mm Permissible Settlement	201	216	225	234	243	232	224	256	268	275	273	255	242	232	324	309	301	293	271	256	245	344	316	306	299	289	271	259

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 2																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 20 mm Permissible Settlement	286	295	280	268	252	240	232	342	314	297	283	264	250	240	342	314	305	298	276	260	249	336	308	299	292	282	265	253

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 2																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 25 mm Permissible Settlement	286	310	322	335	315	300	290	364	382	371	354	330	313	301	428	393	381	372	344	325	311	420	385	374	366	353	331	316

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 3																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 20 mm Permissible Settlement	89	96	96	92	86	82	79	115	108	102	97	90	86	82	117	107	104	102	94	89	85	116	107	104	101	98	92	87

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 3																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 25 mm Permissible Settlement	89	96	99	103	108	103	99	115	119	122	121	113	107	103	141	134	130	127	117	111	106	145	133	129	126	122	115	109

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 4																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 20 mm Permissible Settlement	283	292	278	266	250	238	230	339	312	294	281	262	248	239	342	314	305	298	276	260	249	336	308	299	292	282	265	253

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 4																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 25 mm Permissible Settlement	283	306	319	332	312	298	288	360	378	368	351	327	310	298	428	393	381	372	344	325	311	420	385	374	366	353	331	316

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 5																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 20 mm Permissible Settlement	131	141	146	142	133	127	122	168	166	157	149	139	132	127	188	172	168	164	151	143	137	195	179	174	170	164	154	147

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 5																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 25 mm Permissible Settlement	131	141	146	152	163	159	153	168	175	179	184	174	165	159	215	216	209	205	189	179	171	244	224	218	212	205	193	184

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 6																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 20 mm Permissible Settlement	286	295	280	268	252	240	232	342	314	297	283	264	250	240	342	314	305	298	276	260	249	336	308	299	292	282	265	253

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 6																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 25 mm Permissible Settlement	286	310	322	335	315	300	290	364	382	371	354	330	313	301	428	393	381	372	344	325	311	420	385	374	366	353	331	316

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 7																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 20 mm Permissible Settlement	119	128	133	129	121	115	111	153	150	142	136	126	120	115	167	154	149	146	135	127	122	161	148	143	140	135	127	121

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 7																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 25 mm Permissible Settlement	119	128	133	138	148	144	139	153	159	163	168	158	150	144	193	192	187	182	169	159	152	201	185	179	175	169	159	151

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 8 (DAMAULI SUBSTATION)																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 20 mm Permissible Settlement	119	128	133	129	121	115	111	153	150	142	136	126	120	115	172	158	154	150	139	131	125	172	158	153	150	144	136	129

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 8 (DAMAULI SUBSTATION)																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 25 mm Permissible Settlement	119	128	133	138	148	144	139	153	159	163	168	158	150	144	198	198	192	188	173	164	157	215	197	191	187	180	169	162

RAFT FOOTING (SQUARE)																					
BOREHOLE 8 (DAMAULI SUBSTATION)																					
Depth of footing, D _f ,m	1.50							2.00							2.50						
Width of footing B,m	4	6	8	10	12	14	16	4	6	8	10	12	14	16	4	6	8	10	12	14	16
Length of footing L,m	4	6	8	10	12	14	16	4	6	8	10	12	14	16	4	6	8	10	12	14	16
Allowable Bearing Capacity in KN/m ² for 40 mm Permissible Settlement	170	204	196	190	187	185	183	197	209	199	193	190	187	185	237	226	214	207	202	199	196

RAFT FOOTING (SQUARE)																												
BOREHOLE 8 (DAMAULI SUBSTATION)																												
Depth of footing, D _f ,m	3.00							3.50							4.00							4.50						
Width of footing B,m	4	6	8	10	12	14	16	4	6	8	10	12	14	16	4	6	8	10	12	14	16	4	6	8	10	12	14	16
Length of footing L,m	4	6	8	10	12	14	16	4	6	8	10	12	14	16	4	6	8	10	12	14	16	4	6	8	10	12	14	16
Allowable Bearing Capacity in KN/m ² for 40 mm Permissible Settlement	272	242	228	220	215	211	208	281	248	232	223	217	213	210	271	238	221	212	206	202	198	253	226	210	201	194	190	187

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 9 (LEKHNATH SUBSTATION)																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 20 mm Permissible Settlement	274	286	271	260	244	233	225	332	305	288	275	256	243	233	328	301	292	285	264	249	238	323	297	288	281	272	255	243

ISOLATED FOOTING (SQUARE)																												
BOREHOLE 9 (LEKHNATH SUBSTATION)																												
Depth of footing, D _f ,m	1.50							2.00							2.50							3.00						
Width of footing B,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length of footing L,m	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Allowable Bearing Capacity in KN/m ² for 25 mm Permissible Settlement	274	296	308	321	305	291	281	348	365	360	343	320	303	291	410	376	365	357	330	311	298	404	371	360	352	339	319	304

RAFT FOOTING (SQUARE)																					
BOREHOLE 9 (LEKHNATH SUBSTATION)																					
Depth of footing, D _f ,m	1.50							2.00							2.50						
Width of footing B,m	4	6	8	10	12	14	16	4	6	8	10	12	14	16	4	6	8	10	12	14	16
Length of footing L,m	4	6	8	10	12	14	16	4	6	8	10	12	14	16	4	6	8	10	12	14	16
Allowable Bearing Capacity in KN/m ² for 40 mm Permissible Settlement	379	398	381	371	365	360	357	428	403	383	372	365	359	356	459	413	391	378	369	363	359

RAFT FOOTING (SQUARE)																												
BOREHOLE 9 (LEKHNATH SUBSTATION)																												
Depth of footing, D _f ,m	3.00							3.50							4.00							4.50						
Width of footing B,m	4	6	8	10	12	14	16	4	6	8	10	12	14	16	4	6	8	10	12	14	16	4	6	8	10	12	14	16
Length of footing L,m	4	6	8	10	12	14	16	4	6	8	10	12	14	16	4	6	8	10	12	14	16	4	6	8	10	12	14	16
Allowable Bearing Capacity in KN/m ² for 40 mm Permissible Settlement	474	423	398	384	374	368	363	490	433	405	389	379	372	366	506	443	413	395	384	376	370	502	450	417	398	386	377	371

- Pile foundation is strictly proposed for Damauli substation due to presence of liquefiable sandy layers below the foundation. Considering soil liquefiable depths from 1.5 m to 9 m, it is analyzed to calculate the allowable pile capacity for various lengths and dimensions of pile taking pile cap at a depth of **1.5 m** from natural ground level for New Boreholes 1, 2, 3, 4 and Borehole 8 (Damauli Substation) which is summarized below:

ALLOWABLE LOAD CARRYING CAPACITY OF CAST-INSITU BORED PILE (IS 2911-1-2)				
BOREHOLE NO:	NEW BH 1, 2,3,4 & BH 8			
Depth of Pile Top	1.5 m below ground level			
Size of Pile, mm	500			
Length of pile, m	9	10.5	12	13.5
ALLOWABLE BEARING CAPACITY, TONNES	18.62	19.56	20.50	21.43

BOREHOLE NO:	NEW BH 1, 2,3,4 & BH 8			
Depth of Pile Top	1.5 m below ground level			
Size of Pile, mm	600			
Length of pile, m	9	10.5	12	13.5
ALLOWABLE BEARING CAPACITY, TONNES	31.91	33.26	34.61	35.95

ALLOWABLE LOAD CARRYING CAPACITY OF CAST-INSITU BORED PILE (IS 2911-1-2)				
BOREHOLE NO:	NEW BH 1, 2,3,4 & BH 8			
Depth of Pile Top	1.5 m below ground level			
Size of Pile, mm	700			
Length of pile, m	9	10.5	12	13.5
ALLOWABLE BEARING CAPACITY, TONNES	50.37	52.21	54.04	55.87

BOREHOLE NO:	NEW BH 1, 2,3,4 & BH 8			
Depth of Pile Top	1.5 m below ground level			
Size of Pile, mm	800			
Length of pile, m	9	10.5	12	13.5
ALLOWABLE BEARING CAPACITY, TONNES	74.78	77.18	79.57	81.96

- Pile Integrity Tests based on IS 14893:2001 or ASTM D 5882-16 or equivalent standards should be followed. Pile Integrity Test on 5 % of working piles and the Ultimate Load Test on pile should be carried out as per equivalent standards.

- If karst/caverns are seen during the construction phase, they should be treated with grouting under the supervision of Geotechnical Engineer after verification from Electrical Resistivity Tomography Test. (ERT).
- IS 2911 and its parts can be referred for quality and workmanship for the bores cast in-situ piles construction.
- The cohesion of the soil can be neglected as being sandy strata. The angle of friction obtained by correlating from SPT N-values is tabulated below:.

BOREHOLE 1 - NEW										
Depth	1.5	3	4.5	6	7.5	9	10.5	12	13.5	15
N-value, Ncorr	21	16	19	13	8	27	33	32	31	30
Angle of Friction in Degrees	31	29	30	27	25	33	35	34	34	34
BOREHOLE 2 - NEW										
Depth	1.5	3	4.5	6	7.5	9	10.5	12	13.5	15
N-value, Ncorr	38	20	34	22	17	10	33	32	31	30
Angle of Friction in Degrees	36	31	35	31	29	26	35	34	34	34
BOREHOLE 3 - NEW										
Depth	1.5	3	4.5	6	7.5	9	10.5	12	13.5	15
N-value, Ncorr	18	22	19	12	6	33	33	32	31	30
Angle of Friction in Degrees	30	31	30	27	24	35	35	34	34	34
BOREHOLE 4 - NEW										
Depth	1.5	3	4.5	6	7.5	9	10.5	12	13.5	15
N-value, Ncorr	38	14	16	19	17	34	33	32	31	30
Angle of Friction in Degrees	36	28	29	30	29	35	35	34	34	34
<i>Note: 1. Above calculations for Angle of Friction is calculated from, $\phi = 15 + \sqrt{(12 * N \text{ corr.})}$ for sandy soils given by Dunham (1954)</i>										

- If filling ground is observed during the construction, the foundation should be placed below the filling ground to reduce the uneven settlements.
- If there is rise in platform for the proposed foundation the embankment filling should be guided as:

The maximum size of the coarse material in the mixture of filling materials shall not exceed 75 mm for general earth fill. The soil with less than 15 percent passing 0.075 mm sieve should be used. The fill materials shall also be free from organic or other deleterious materials so as not to cause corrosion of the soil reinforcement and the fascia panels. The CBR value of any embankment fill materials should be greater than 5%. The fill material

shall have liquid limit not exceeding 35 plasticity index value should not be greater than 6. Embankment foundations shall be excavated/furrowed and brought under Optimum Moisture Content and re-compacted in layers of 150 mm each in order to achieve the required level of compaction. Layers of material other than rock fill shall not exceed 150 mm compacted depth. The filling materials can be acquired from the hills (reddish brown silty clayey gravels) in the vicinity or can be acquired from river bed materials of Madi river or Marshyangdi river.

- The slope of the excavation should be maintained at about 45° to prevent the slope from collapsing during excavation or construction period.
- Because of presence of seepage water and consideration of probable rise in water table in monsoon, side fall (collapse) is eminent. So, at the time of construction of foundation, it is strongly recommended to design the appropriate site protection measures based on the soil properties shown in this report.
- The above recommendation is based on the mentioned methodology of our analysis. It is worth mentioning that the allowable bearing capacity depends on many variables such as allowable settlement, type of foundation, size and depth of foundation, importance of structure, cost of project etc. Therefore, based on soil index properties data and engineering properties data provided in this report, the foundation designer is free to refine the calculations wherever he feels necessary.

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Nepal Building Codes

IS: 1498 Classification and identification of soils for general engineering purposes

IS: 1892 Code of practice for subsurface Investigation for foundation

IS: 2131 Method of standard penetration test for soils

IS: 2132 Code of practice for thin walled tube sampling of soils

IS: 2720 Method of test for soils (Relevant parts)

Prepared By:

Ritesh Baral

Geotechnical Engineer

Council Number –9537 Civil “A”

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ANNEX-I
LOG OF BOREHOLES

BOREHOLE NO:- 1

PROJECT : Geotechnical Investigation of Proposed Site

CLIENT : Nepal Electricity Authority

LOCATION : Kaski

Drilling Method : Auger

Inclination of Hole: Vertical

Borehole Coordinates: 28°11'38.21"N 84°6'8.79"E

Total Depth, m : 6.0

Depth to Ground Water: NA

Soil Description		Symbol	Depth, m	Test Type	No. of blows			N-Value	SPT		***
					15 cm	15 cm	15 cm		N Value	DCPT	
0 10 20 30 40 50											0
Dense reddish brownish sandy SILT with low plastic clay and gravels			1		SPT	10	15	19	34		1.5

			2		SPT	12	16	20	36	3	

			3		SPT	13	18	22	40	4.5	

			4		SPT	13	20	27	47	6	

			5		SPT	13	20	27	47		

			6		SPT	13	20	27	47		

Types of Soil		N Value									
Granular Soil	Compactness	0 to 4		4 to 10		10 to 30		30 to 50		> 50	
		Very Loose	Loose	Med. Dense		Dense		Very Dense			
Cohesive Soil	Consistency	0 to 2		2 to 4		4 to 8		8 to 16		16 to 32	
		Very Soft	Soft	Med. Soft		Stiff		Very Stiff		Hard	

BOREHOLE NO:- 2

PROJECT : Geotechnical Investigation of Proposed Site

CLIENT : Nepal Electricity Authority

LOCATION : Kaski

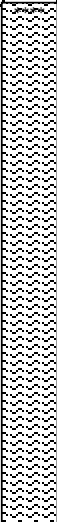
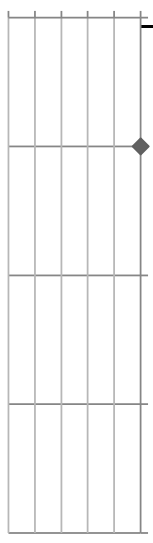
Drilling Method : Auger

Inclination of Hole: Vertical

Borehole Coordinates: 28°10'6.84"N 84°9'48.6"E

Total Depth, m : **1.5**

Depth to Ground Water: NA

Soil Description	Symbol	Depth, m	Test Type	No. of blows			N-Value	SPT		***
				15 cm	15 cm	15 cm		N Value	DCPT	
Very dense brownish highly fractured and weathered rock of Phyllite		1	** SPT	50/3			> 50		0	
		2							1.5	
		3							3	
		4								
		5							4.5	
		6							6	
Note: Drilling could be carried out up to depth of 1.5 m due to presence of Bed rock from Auger method of drilling.										
Types of Soil		N Value								
Granular Soil	Compactness	0 to 4	4 to 10	10 to 30	30 to 50	> 50				
		Very Loose	Loose	Med. Dense	Dense	Very Dense				
Cohesive Soil	Consistency	0 to 2	2 to 4	4 to 8	8 to 16	16 to 32	> 32			
		Very Soft	Soft	Med. Soft	Stiff	Very Stiff	Hard			

BOREHOLE NO:- 3

PROJECT : Geotechnical Investigation of Proposed Site

CLIENT : Nepal Electricity Authority

LOCATION : Damauli

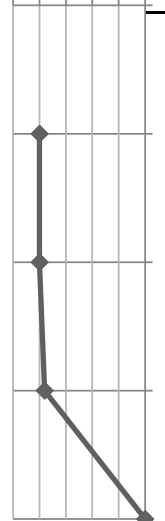
Drilling Method : Auger

Inclination of Hole: Vertical

Borehole Coordinates: 28°8'14.65"N 84°12'10.47"E

Total Depth, m : **6.0**

Depth to Ground Water: NA

Soil Description		Symbol	Depth, m	Test Type	No. of blows			N-Value	SPT		***
					15 cm	15 cm	15 cm		N Value	DCPT	
Loose to medium dense reddish brown clayey SILT with small gravels and sand			1		SPT	2	5	5	10		
				**							
			2		SPT						
				**							
Very dense reddish brown clayey GRAVELS with traces of sand			3		SPT	3	3	7	10		
				**							
			4		SPT						
				**							
			5		SPT	2	6	6	12		
			6			SPT	42	50/3		> 50	
				**							
Types of Soil		N Value									
Granular Soil	Compactness	0 to 4	4 to 10	10 to 30		30 to 50		> 50			
		Very Loose	Loose	Med. Dense		Dense		Very Dense			
Cohesive Soil	Consistency	0 to 2	2 to 4	4 to 8		8 to 16		16 to 32		> 32	
		Very Soft	Soft	Med. Soft		Stiff		Very Stiff		Hard	

BOREHOLE NO:- 4

PROJECT : Geotechnical Investigation of Proposed Site

CLIENT : Nepal Electricity Authority

LOCATION : Sishaghat

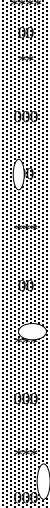
Drilling Method : Auger

Inclination of Hole:Vertical

Borehole Coordinates: 28°4'30.66"N 84°13'54.39"E

Total Depth, m : 6.0

Depth to Ground Water: NA

Soil Description	Symbol	Depth, m	Test Type	No. of blows			N-Value	SPT		***
				15 cm	15 cm	15 cm		N Value	DCPT	
Very dense brownish very silty sandy GRAVELS and BOULDERS		1								
		**	SPT	13	20	27	47			
		2								
		**	SPT	21	33	40	> 50			
		3								
		**	SPT	40	50/3		> 50			
		4								
		**	SPT	50/5			> 50			
		5								
		**	SPT				> 50			
		6								
		**	SPT				> 50			
Types of Soil		N Value								
Granular Soil	Compactness	0 to 4	4 to 10	10 to 30	30 to 50	> 50				
		Very Loose	Loose	Med. Dense	Dense	Very Dense				
Cohesive Soil	Consistency	0 to 2	2 to 4	4 to 8	8 to 16	16 to 32	> 32			
		Very Soft	Soft	Med. Soft	Stiff	Very Stiff	Hard			

BOREHOLE NO:- 5

PROJECT : Geotechnical Investigation of Proposed Site

CLIENT : Nepal Electricity Authority

LOCATION : Ranitari, Tanahun

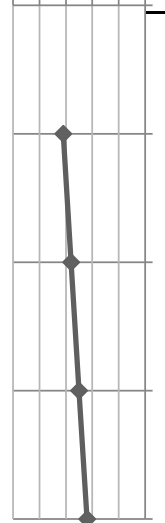
Drilling Method : Auger

Inclination of Hole: Vertical

Borehole Coordinates: 28°0'38.13"N 84°13'3.56"E

Total Depth, m : **6.0**

Depth to Ground Water: NA

Soil Description		Symbol	Depth, m	Test Type	No. of blows			N-Value	SPT		**			
					15 cm	15 cm	15 cm		N Value	DCPT				
Medium dense to dense brownish sandy SILT with low plastic clay			1		SPT	7	8	11	19		0			
				**								1.5		
			2									3		
			3	**	SPT	11	10	12	22					
			4									4.5		
			5	**	SPT	10	12	13	25					
			6									6		
				**	SPT	11	13	15	28					
			Types of Soil		N Value									
			Granular Soil	Compactness	0 to 4	4 to 10	10 to 30		30 to 50		> 50			
Very Loose	Loose	Med. Dense			Dense	Very Dense								
Cohesive Soil	Consistency	0 to 2	2 to 4	4 to 8		8 to 16		16 to 32	> 32					
		Very Soft	Soft	Med. Soft		Stiff	Very Stiff	Hard						

BOREHOLE NO:- 6

PROJECT : Geotechnical Investigation of Proposed Site

CLIENT : Nepal Electricity Authority

LOCATION : Damauli

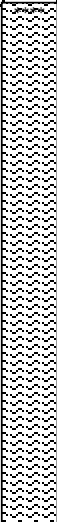
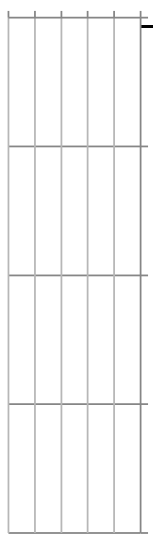
Drilling Method : Auger

Inclination of Hole: Vertical

Borehole Coordinates: 27°57'38.51"N 84°15'35.55"E

Total Depth, m : **1.5**

Depth to Ground Water: NA

Soil Description	Symbol	Depth, m	Test Type	No. of blows			N-Value	SPT		**
				15 cm	15 cm	15 cm		N Value	DCPT	
Very dense brownish highly fractured and weathered rock of Phyllite		1	** SPT	19	29	42	71		0	
		2							1.5	
		3							3	
		4								
		5							4.5	
		6							6	
Note: Drilling could be carried out up to depth of 1.5 m due to presence of Bed rock from Auger method of drilling.										
Types of Soil		N Value								
Granular Soil	Compactness	0 to 4	4 to 10	10 to 30	30 to 50	> 50				
		Very Loose	Loose	Med. Dense	Dense	Very Dense				
Cohesive Soil	Consistency	0 to 2	2 to 4	4 to 8	8 to 16	16 to 32	> 32			
		Very Soft	Soft	Med. Soft	Stiff	Very Stiff	Hard			

BOREHOLE NO:- 7

PROJECT : Geotechnical Investigation of Proposed Site

CLIENT : Nepal Electricity Authority

LOCATION : Bahungaun, Damauli

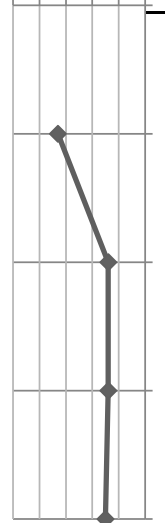
Drilling Method : Auger

Inclination of Hole: Vertical

Borehole Coordinates: 27°56'48.77"N 84°16'41.71"E

Total Depth, m : **6.0**

Depth to Ground Water: NA

Soil Description		Symbol	Depth, m	Test Type	No. of blows			N-Value	SPT		***		
					15 cm	15 cm	15 cm		N Value	DCPT			
Medium dense to dense brownish sandy SILT with small gravels and clay			1		SPT	7	8	9	17		0		
				**									
			2										
			3	**	SPT	10	18	18	36			3	
			4										
				**	SPT	11	16	20	36			4.5	
			5										
				**	SPT	13	18	17	35			6	
			6										
				**	SPT								
			Types of Soil		N Value								
Granular Soil	Compactness	0 to 4	4 to 10	10 to 30		30 to 50		> 50					
		Very Loose	Loose	Med. Dense		Dense		Very Dense					
Cohesive Soil	Consistency	0 to 2	2 to 4	4 to 8		8 to 16		16 to 32		> 32			
		Very Soft	Soft	Med. Soft		Stiff		Very Stiff		Hard			

BOREHOLE NO:- 8 (DAMAULI SUBSTATION)

PROJECT : Geotechnical Investigation of Proposed Substation Site

CLIENT : Nepal Electricity Authority

LOCATION : Damauli, Tanahun

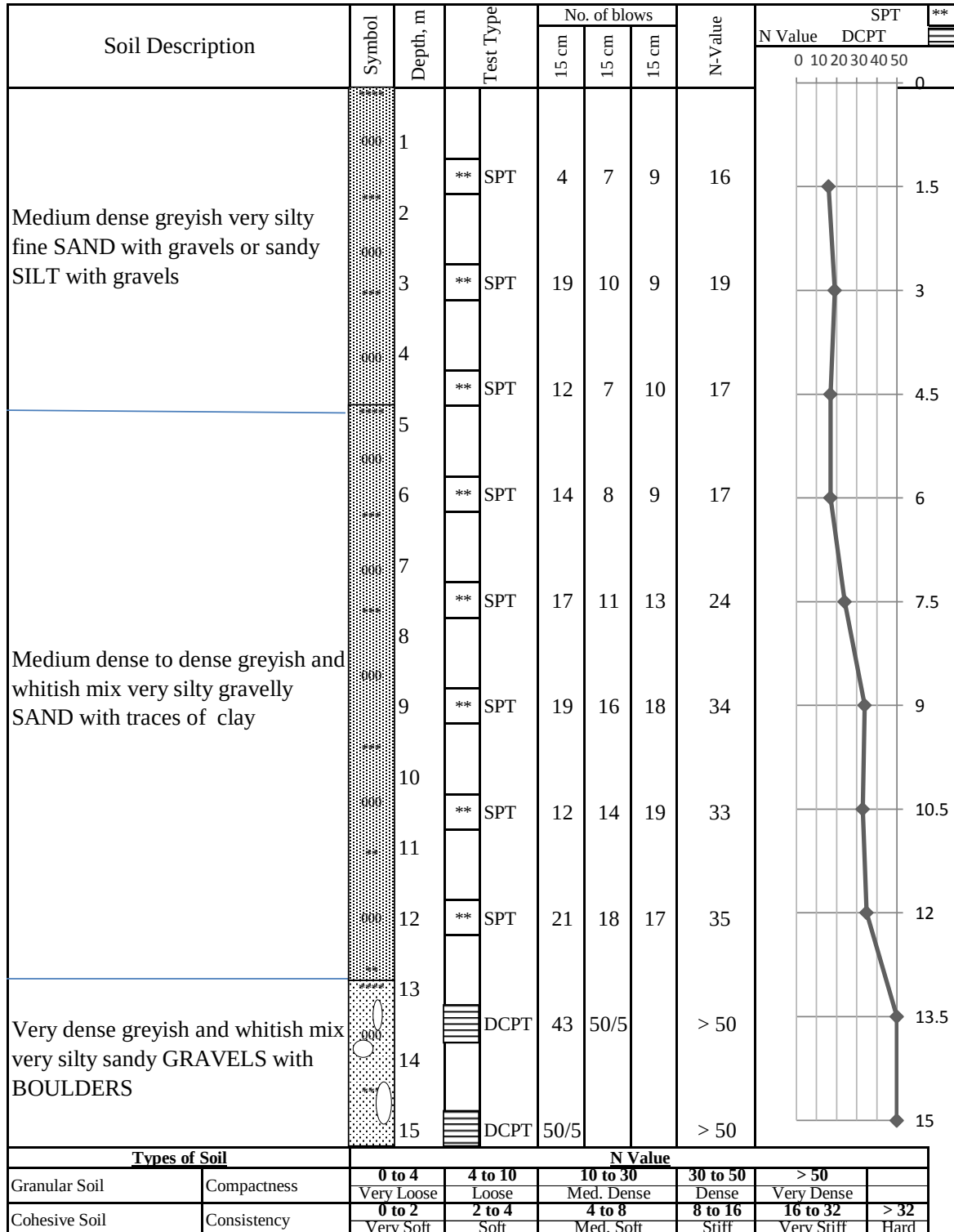
Drilling Method : Rotary

Inclination of Hole: Vertical

Borehole Coordinates: 27°58'5.53"N 84°17'35.95"E

Total Depth, m : **15.0**

Depth to Ground Water: 3.5 m



BOREHOLE NO:- 9 (LEKHNATH SUBSTATION)

PROJECT : Geotechnical Investigation of Proposed Site
 CLIENT : Nepal Electricity Authority
 LOCATION : Pokhara Metropolitan City, Argau, Lekhnath
 Drilling Method : Rotary
 Inclination of Hole: Vertical
 Borehole Coordinates: 28°10'47.96"N 84° 3'22.89"E

Total Depth, m : **15.0**
 Depth to Ground Water: 3.4 m

Soil Description	Symbol	Depth, m	Test Type	No. of blows			N-Value	SPT		**
				15 cm	15 cm	15 cm		N Value	DCPT	
0 10 20 30 40 50										0
Very dense light greyish sandy silty GRAVELS with BOULDERS with few traces of clay		1								
		2	DCPT	18	34	42	51			1.5
		3	DCPT	17	48	50/6	> 50			3
		4								
		5	DCPT	29	50/7		> 50			4.5
		6	DCPT	37	42	50/9	> 50			6
		7								
		8	DCPT	32	50/2		> 50			7.5
		9	DCPT	19	50/6		> 50			9
		10	DCPT	46	50/7		> 50			10.5
		11								
		12	DCPT	27	40	50/3	> 50			12
		13								
		14	DCPT	80	37	50/7	> 50			13.5
		15	DCPT	27	50/11		> 50			15
Types of Soil		N Value								
Granular Soil	Compactness	0 to 4	4 to 10	10 to 30		30 to 50	> 50			
		Very Loose	Loose	Med. Dense		Dense	Very Dense			
Cohesive Soil	Consistency	0 to 2	2 to 4	4 to 8		8 to 16	16 to 32	> 32		
		Very Soft	Soft	Med. Soft		Stiff	Verv Stiff	Hard		

BOREHOLE : 1 (NEW) (DAMAULI SUBSTATION)

PROJECT : Geotechnical Investigation of Proposed Substation Site

CLIENT : Nepal Electricity Authority

LOCATION : Damauli, Tanahun

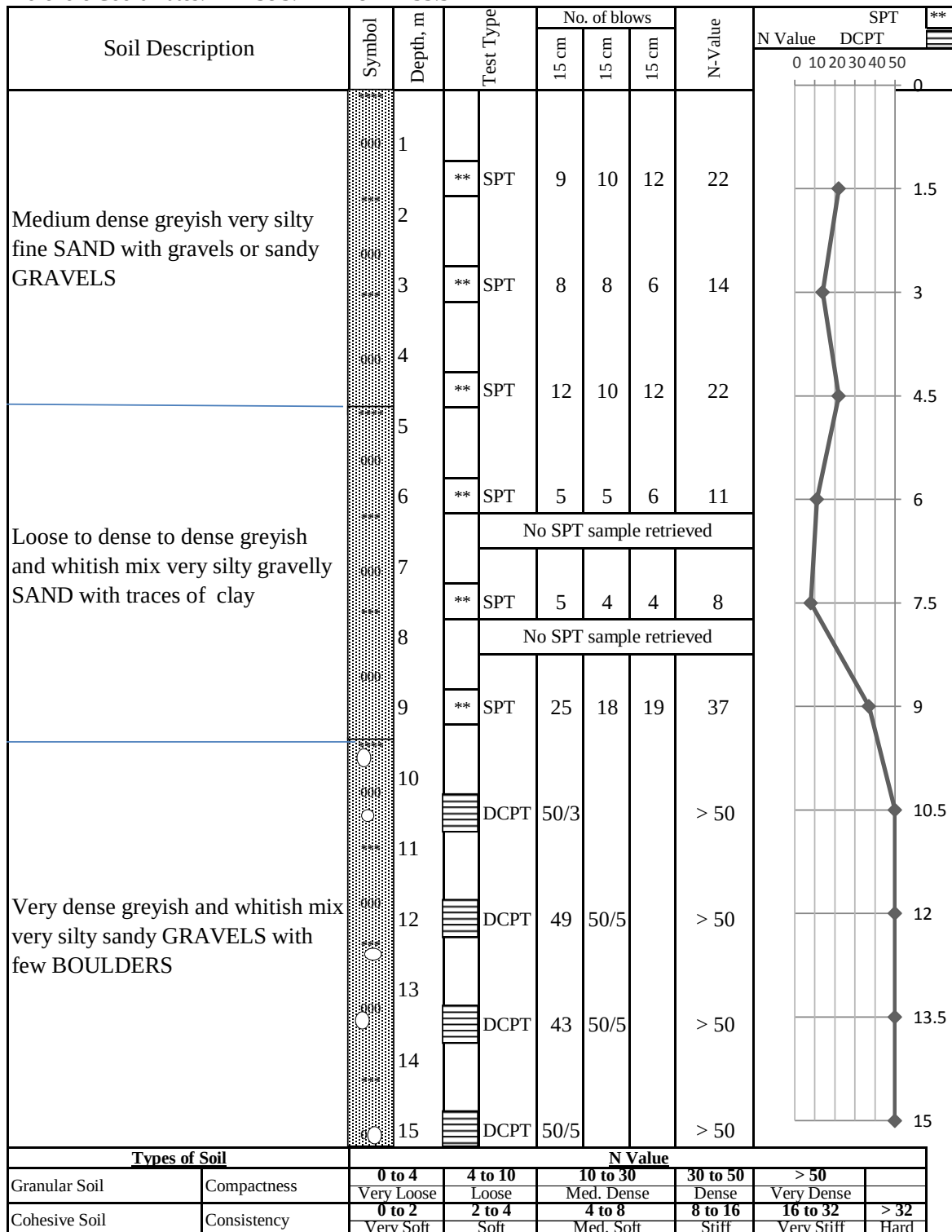
Drilling Method : Rotary

Inclination of Hole:Vertical

Borehole Coordinates: 27°58'3.14"N 84°17'33.52"E

Total Depth, m : 15.0

Depth to Ground Water: 2.5 m



BOREHOLE : 2 (NEW) (DAMAULI SUBSTATION)

PROJECT : Geotechnical Investigation of Proposed Substation Site

CLIENT : Nepal Electricity Authority

LOCATION : Damauli, Tanahun

Drilling Method : Rotary

Inclination of Hole: Vertical

Borehole Coordinates: 27°58'6.38"N 84°17'33.67"E

Total Depth, m : **15.0**

Depth to Ground Water: 4 m

Soil Description	Symbol	Depth, m	Test Type	No. of blows			N-Value	SPT		**								
				15 cm	15 cm	15 cm		N Value	DCPT									
											0	10	20	30	40	50		
Medium dense to very dense greyish very silty fine SAND with gravels		1	*** SPT	27	39	50/3	> 50			1.5								
		2									*** SPT	6	9	13	22			3
		3																
Very dense brownish silty sandy GRAVELS with BOULDERS	4	*** SPT	22	50/2	> 50			4.5										
Medium dense greyish and whitish mix silty gravelly medium to fine SAND or gravelly sandy SILT with traces of clay		5	*** SPT	11	12	14	26			6								
		6																
		7																
		*** SPT									5	9	9	18			7.5	
		8																
		9									*** SPT	7	7	3	10			9
Very dense greyish very silty sandy GRAVELS with BOULDERS		10	DCPT	50/5			> 50			10.5								
		11																
		12									DCPT	43	50/7	> 50			12	
		13									DCPT	50/7	> 50			13.5		
		14																
		15									DCPT	50/3	> 50			15		
Types of Soil		N Value																
Granular Soil	Compactness	0 to 4	4 to 10	10 to 30	30 to 50	> 50												
		Very Loose	Loose	Med. Dense	Dense	Very Dense												
Cohesive Soil	Consistency	0 to 2	2 to 4	4 to 8	8 to 16	16 to 32	> 32											
		Very Soft	Soft	Med. Soft	Stiff	Very Stiff	Hard											

BOREHOLE : 3 (NEW) (DAMAULI SUBSTATION)

PROJECT : Geotechnical Investigation of Proposed Substation Site

CLIENT : Nepal Electricity Authority

LOCATION : Damauli, Tanahun

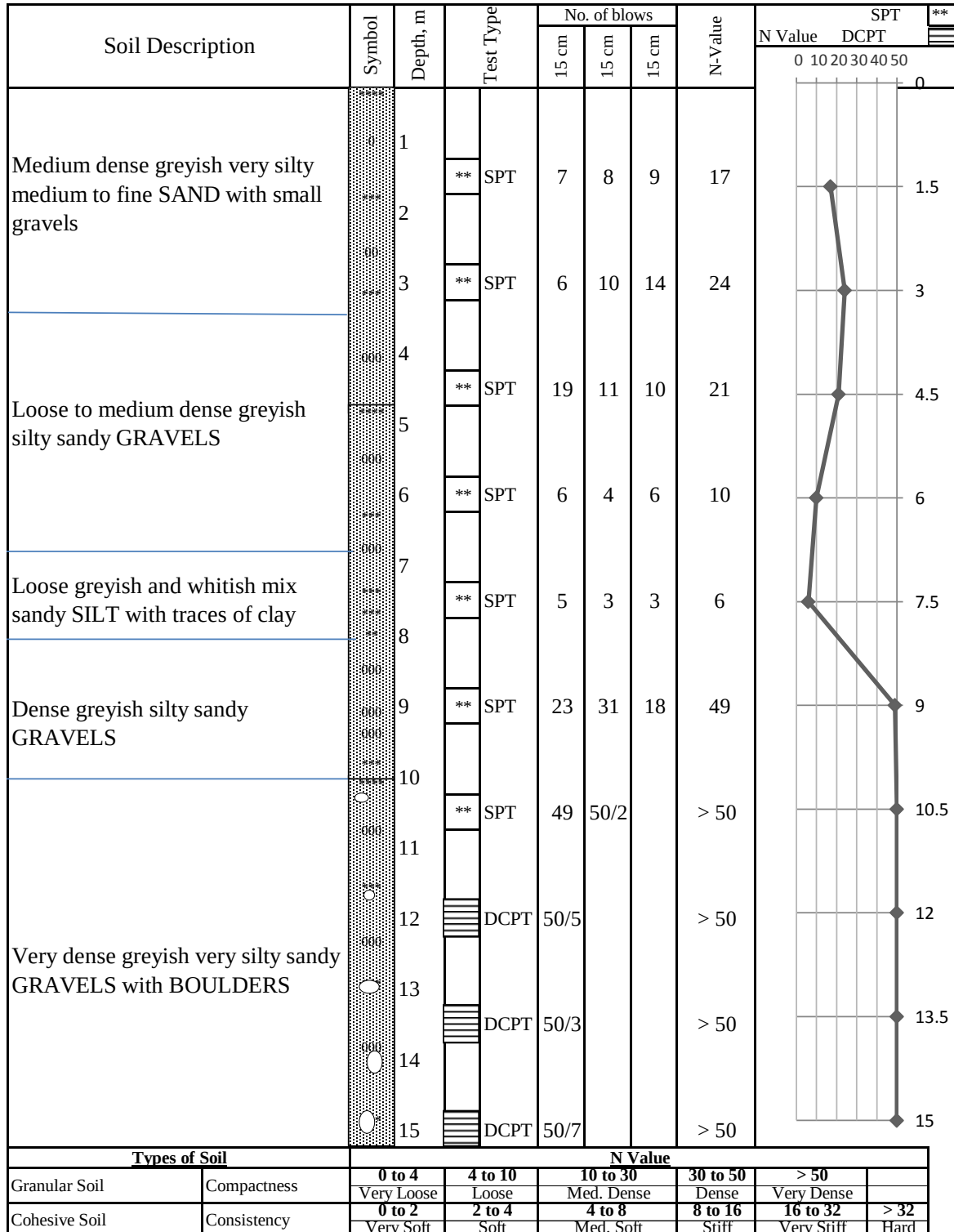
Drilling Method : Rotary

Inclination of Hole: Vertical

Borehole Coordinates: 27°58'4.92"N 84°17'35.53"E

Total Depth, m : **15.0**

Depth to Ground Water: 2 m



BOREHOLE : 4 (NEW) (DAMAULI SUBSTATION)

PROJECT : Geotechnical Investigation of Proposed Substation Site

CLIENT : Nepal Electricity Authority

LOCATION : Damauli, Tanahun

Drilling Method : Rotary

Inclination of Hole: Vertical

Borehole Coordinates: 27°58'4.47"N 84°17'32.16"E

Total Depth, m : **15.0**

Depth to Ground Water: 2.5 m

Soil Description	Symbol	Depth, m	Test Type	No. of blows			N-Value	SPT		**
				15 cm	15 cm	15 cm		N Value	DCPT	
				15 cm	15 cm	15 cm		0 10 20 30 40 50		
Top brownish medium dense sandy SILT with traces of clay		1								
Very dense brownish silty sandy GRAVELS with BOULDERS		2	DCPT	29	50/3		> 50			
Medium dense greyish and whitish mix very silty SAND and GRAVELS or gravelly sandy SILT with traces of clay		3	SPT	19	6	6	12			
		4								
		5	SPT	6	9	7	16			
		6	SPT	10	14	7	21			
		7								
		8	SPT	13	10	8	18			
		9	SPT	14	16	50/7	> 50			
		10								
Very dense greyish very silty sandy GRAVELS with BOULDERS		11	DCPT	50/1			> 50			
		12	DCPT	43	50/2		> 50			
		13								
		14	DCPT	50/5			> 50			
		15	DCPT	50/10			> 50			
Types of Soil		N Value								
Granular Soil	Compactness	0 to 4	4 to 10	10 to 30	30 to 50	> 50				
		Very Loose	Loose	Med. Dense	Dense	Very Dense				
Cohesive Soil	Consistency	0 to 2	2 to 4	4 to 8	8 to 16	16 to 32	> 32			
		Very Soft	Soft	Med. Soft	Stiff	Very Stiff	Hard			

ANNEX-II
LABORATORY TEST
RESULTS

Moisture Content								
Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines								
Location : Kaski and Tanahun Districts								
Test Method			IS: 2720 Part II					
S.N	Sample	Depth m	Mass (gm) of					Moisture Content %
			Wet Soil + Container	Dry Soil + Container	Container	Moisture	Dry Soil	
Bore Hole 1								
1	SPT	1.50	129.00	110.00	4.00	19.00	106.00	17.92
2	SPT	3.00	182.50	147.50	4.00	35.00	143.50	24.39
3	SPT	4.50	208.50	177.00	4.00	31.50	173.00	18.21
4	SPT	6.00	202.00	159.00	4.00	43.00	155.00	27.74
Bore Hole 3								
1	Disturbed	1.00	1090.00	850.00	147.68	240.00	702.32	34.17
2	SPT	1.50	790.00	600.00	108.00	190.00	492.00	38.62
3	Disturbed	2.00	830.00	650.00	156.00	180.00	494.00	36.44
4	SPT	3.00	870.00	640.00	97.09	230.00	542.91	42.36
5	SPT	4.50	750.00	560.00	155.00	190.00	405.00	46.91
6	Disturbed	5.00	665.00	521.00	102.30	144.00	418.70	34.39

Moisture Content								
Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines								
Location : Kaski and Tanahun Districts								
Test Method		IS: 2720 Part II						
S.N	Sample	Depth m	Mass (gm) of					Moisture Content %
			Wet Soil + Container	Dry Soil + Container	Container	Moisture	Dry Soil	
Bore Hole 4								
1	SPT	1.50	165.50	146.50	4.00	19.00	142.50	13.33
2	SPT	3.00	180.50	168.50	4.00	12.00	164.50	7.29
3	SPT	4.50	200.00	178.00	4.00	22.00	174.00	12.64
4	SPT	6.00	145.00	124.00	4.00	21.00	120.00	17.50
Bore Hole 5								
1	SPT	1.50	145.50	120.00	4.00	25.50	116.00	21.98
2	SPT	3.00	177.50	142.50	4.00	35.00	138.50	25.27
3	SPT	4.50	166.00	137.00	4.00	29.00	133.00	21.80
4	SPT	6.00	180.00	146.50	4.00	33.50	142.50	23.51

Moisture Content								
Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines								
Location : Kaski and Tanahun Districts								
Test Method		IS: 2720 Part II						
S.N	Sample	Depth m	Mass (gm) of					Moisture Content %
			Wet Soil + Container	Dry Soil + Container	Container	Moisture	Dry Soil	
Bore Hole 7								
1	SPT	1.50	149.50	117.00	4.00	32.50	113.00	28.76
2	SPT	3.00	208.50	183.50	4.00	25.00	179.50	13.93
3	SPT	4.50	185.50	162.00	4.00	23.50	158.00	14.87
4	SPT	6.00	221.50	191.50	4.00	30.00	187.50	16.00
Bore Hole 8 - DAMAULI SUBSTATION								
1	SPT	1.50	206.50	184.00	4.00	22.50	180.00	12.50
2	SPT	3.00	186.00	177.00	4.00	9.00	173.00	5.20
3	SPT	4.50	160.00	131.50	4.00	28.50	127.50	22.35
4	SPT	6.00	141.00	132.00	4.00	9.00	128.00	7.03
5	SPT	7.50	170.00	159.50	4.00	10.50	155.50	6.75
6	SPT	9.00	181.50	171.50	4.00	10.00	167.50	5.97
7	SPT	10.50	175.50	167.50	4.00	8.00	163.50	4.89
8	SPT	12.00	204.00	196.00	4.00	8.00	192.00	4.17
Bore Hole 9 - LEKHNATH SUBSTATION								
1	Disturbed	1.50	133.50	110.00	4.00	23.50	106.00	22.17
2	Disturbed	3.00	200.00	171.00	4.00	29.00	167.00	17.37
3	Disturbed	7.50	212.00	180.00	4.00	32.00	176.00	18.18
4	Disturbed	9.00	221.50	188.00	4.00	33.50	184.00	18.21

SPECIFIC GRAVITY TEST OF SOIL SOLIDS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

Location : Kaski and Tanahun Districts

Testing Method **IS : 2720 Part 3**

Bore Hole No.		1				3		
Depth	m	1.5	3.0	4.5	6.0	1.5	3.0	4.5
Sample		SPT	SPT	SPT	SPT	SPT	SPT	SPT
Wt. Pycnometer + Water + Soil	gm	176.28	180.80	176.22	180.65	176.33	180.96	176.85
Temperature	°C	30	30	30	29	30	29	30
Wt. Pycnometer + Water	gm	157.70	161.80	157.72	162.01	157.92	162.62	158.33
Wt. Soil	gm	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Specific Gravity of Water		0.9957	0.9957	0.9957	0.9960	0.9957	0.9960	0.9957
Specific Gravity of Soil Solids		2.62	2.72	2.60	2.63	2.58	2.56	2.60

SPECIFIC GRAVITY TEST OF SOIL SOLIDS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

Location : Kaski and Tanahun Districts

Testing Method **IS : 2720 Part 3**

Bore Hole No.		4			5	
Depth	m	1.5	3.0	4.5	1.5	4.5
Sample		SPT	SPT	SPT	SPT	SPT
Wt. Pycnometer + Water + Soil	gm	180.84	176.24	180.65	180.75	176.20
Temperature	°C	29	30	29	29	30
Wt. Pycnometer + Water	gm	162.20	157.50	162.10	162.30	157.89
Wt. Soil	gm	30.0	30.0	30.0	30.0	30.0
Specific Gravity of Water		0.9957	0.9957	0.9960	0.9960	0.9957
Specific Gravity of Soil Solids		2.63	2.65	2.61	2.59	2.56

SPECIFIC GRAVITY TEST OF SOIL SOLIDS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

Location : Kaski and Tanahun Districts

Testing Method **IS : 2720 Part 3**

Bore Hole No.		7		
Depth	m	1.5	3.0	4.5
Sample		SPT	SPT	SPT
Wt. Pycnometer + Water + Soil	gm	180.84	176.24	180.65
Temperature	°C	29	30	29
Wt. Pycnometer + Water	gm	162.32	157.66	162.10
Wt. Soil	gm	30.0	30.0	30.0
Specific Gravity of Water		0.9957	0.9957	0.9960
Specific Gravity of Soil Solids		2.60	2.62	2.61

SPECIFIC GRAVITY TEST OF SOIL SOLIDS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

Location : Kaski and Tanahun Districts

Testing Method **IS : 2720 Part 3**

Bore Hole No.		8 - DAMAULI SUBSTATION				9 - LEKHNATH SS	
Depth	m	1.5	4.5	7.5	10.5	4.5	9.0
Sample		SPT	SPT	SPT-1	SPT-2	Disturbed	Disturbed
Wt. Pycnometer + Water + Soil	gm	180.75	176.20	181.14	184.59	180.72	176.18
Temperature	°C	29	30	28	30	29	30
Wt. Pycnometer + Water	gm	162.22	157.56	162.70	166.10	162.10	157.59
Wt. Soil	gm	30.0	30.0	30.0	30.0	30.0	30.0
Specific Gravity of Water		0.9960	0.9957	0.9963	0.9958	0.9960	0.9957
Specific Gravity of Soil Solids		2.61	2.63	2.59	2.60	2.63	2.62

Moisture Content

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

Location : Damauli, Tanahun

Test Method		IS: 2720 Part II						
S.N	Sample	Depth m	Mass (gm) of					Moisture Content %
			Wet Soil + Container	Dry Soil + Container	Container	Moisture	Dry Soil	
Borehole 1 - NEW								
1	SPT	1.50	445.00	430.00	90.01	15.00	339.99	4.41
2	SPT	3.00	445.00	405.00	108.00	40.00	297.00	13.47
3	SPT	4.50	525.00	490.00	89.52	35.00	400.48	8.74
4	Disturbed	6.00	580.00	520.00	128.23	60.00	391.77	15.32
5	Disturbed	7.50	720.00	620.00	87.56	100.00	532.44	18.78
6	SPT	9.00	340.00	325.00	91.23	15.00	233.77	6.42
7	Disturbed	10.50	810.00	710.00	91.29	100.00	618.71	16.16
8	Disturbed	12.00	940.00	840.00	156.74	100.00	683.26	14.64
9	Disturbed	13.50	610.00	540.00	88.40	70.00	451.60	15.50
10	Disturbed	15.00	555.00	495.00	93.46	60.00	401.54	14.94
Borehole 2 - NEW								
1	SPT	1.50	200.00	195.00	17.75	5.00	177.25	2.82
1	SPT	3.00	175.00	170.00	20.45	5.00	149.55	3.34
1	SPT	4.50	710.00	620.00	156.00	90.00	464.00	19.40
1	SPT	6.00	650.00	630.00	155.00	20.00	475.00	4.21
1	SPT	7.50	1525.00	1270.00	162.85	255.00	1107.15	23.03
1	SPT	7.50	330.00	320.00	108.00	10.00	212.00	4.72
1	SPT	9.00	395.00	370.00	155.67	25.00	214.33	11.66
1	Disturbed	10.50	745.00	740.00	91.23	5.00	648.77	0.77

Borehole 3 - NEW								
1	SPT	1.50	380.00	351.23	89.52	28.77	261.71	10.99
2	SPT	3.00	1010.00	925.00	156.00	85.00	769.00	11.05
3	SPT	4.50	750.00	720.00	97.09	30.00	622.91	4.82
4	Disturbed	6.00	865.00	830.00	138.45	35.00	691.55	5.06
5	SPT	7.50	635.00	515.00	88.40	120.00	426.60	28.13
6	SPT	9.00	945.00	885.00	162.85	60.00	722.15	8.31
7	Disturbed	9.00	840.00	820.00	91.23	20.00	728.77	2.74
8	Disturbed	10.00	425.00	380.00	89.52	45.00	290.48	15.49
9	Disturbed	10.50	345.00	305.00	90.01	40.00	214.99	18.61
10	Disturbed	10.50	735.00	720.00	95.15	15.00	624.85	2.40
11	Disturbed	12.00	320.00	280.00	93.46	40.00	186.54	21.44
12	Disturbed	13.50	470.00	395.00	155.00	75.00	240.00	31.25
13	Disturbed	15.00	155.00	130.00	17.25	25.00	112.75	22.17
Borehole 4 - NEW								
1	SPT	3.00	370.00	360.00	140.00	10.00	220.00	4.55
2	SPT	4.50	510.00	480.00	86.33	30.00	393.67	7.62
3	SPT	6.00	755.00	715.00	128.23	40.00	586.77	6.82
4	SPT	7.50	395.00	375.00	147.68	20.00	227.32	8.80
5	SPT	9.00	680.00	620.00	156.74	60.00	463.26	12.95
6	Disturbed	10.50	930.00	925.00	88.40	5.00	836.60	0.60
7	Disturbed	12.00	570.00	565.00	156.00	5.00	409.00	1.22
8	Disturbed	13.50	495.00	490.00	95.15	5.00	394.85	1.27
9	Disturbed	15.00	565.00	560.00	89.52	5.00	470.48	1.06

SPECIFIC GRAVITY TEST OF SOIL SOLIDS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

Location : Damauli, Tanahun

Testing Method **IS : 2720 Part 3**

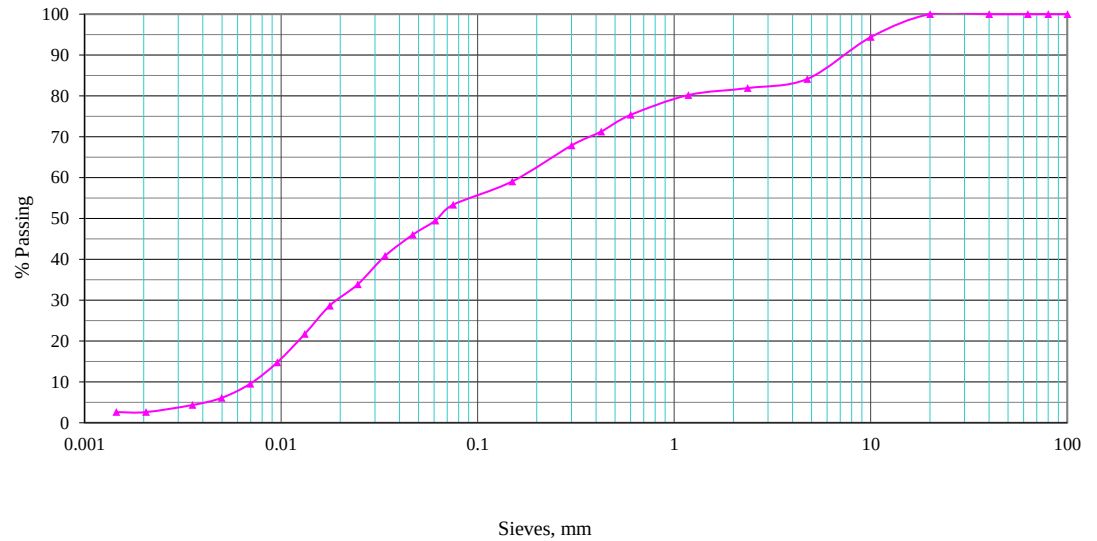
Bore Hole No.		1				2			3			4		
Depth	m	1.5	3.0	4.5	9.0	3.0	6.0	7.5	1.5	3.0	7.5	3.0	4.5	6.0
Sample		SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT
Wt. Pycnometer + Water + Soil	gm	181.60	181.00	176.20	180.80	178.40	174.90	185.40	178.50	174.60	178.39	181.14	184.59	188.56
Temperature	°C	29	24	26	24	26	28	29	26	24	26	28	30	32
Wt. Pycnometer + Water	gm	163.10	162.59	157.62	162.32	159.90	156.40	166.89	159.96	156.10	159.90	162.70	166.01	169.92
Wt. Soil	gm	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Specific Gravity of Water		0.9960	0.9973	0.9968	0.9973	0.9968	0.9963	0.9960	0.9968	0.9973	0.9968	0.9963	0.9958	0.9953
Specific Gravity of Soil Solids		2.60	2.58	2.62	2.60	2.60	2.60	2.60	2.61	2.60	2.60	2.59	2.62	2.63

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Kaski

Bore Hole : 1
Sample : SPT
Total Wt. (gm) 152.40
Depth (m): 1.5

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	8.560	8.560	5.617	94.38
4.750	15.620	24.180	15.866	84.13
2.360	3.400	27.580	18.097	81.90
1.180	2.600	30.180	19.803	80.20
0.600	7.400	37.580	24.659	75.34
0.425	6.200	43.780	28.727	71.27
0.300	5.200	48.980	32.139	67.86
0.150	13.400	62.380	40.932	59.07
0.075	8.700	71.080	46.640	53.36
0.061				49.50
0.047				46.02
0.034				40.81
0.025				33.87
0.018				28.66
0.013				21.71
0.010				14.76
0.007				9.55
0.005				6.08
0.004				4.34
0.002				2.61
0.001				2.61



CLAY	SILT	SAND	GRAVEL
2.61 %	50.75 %	30.77 %	15.87 %

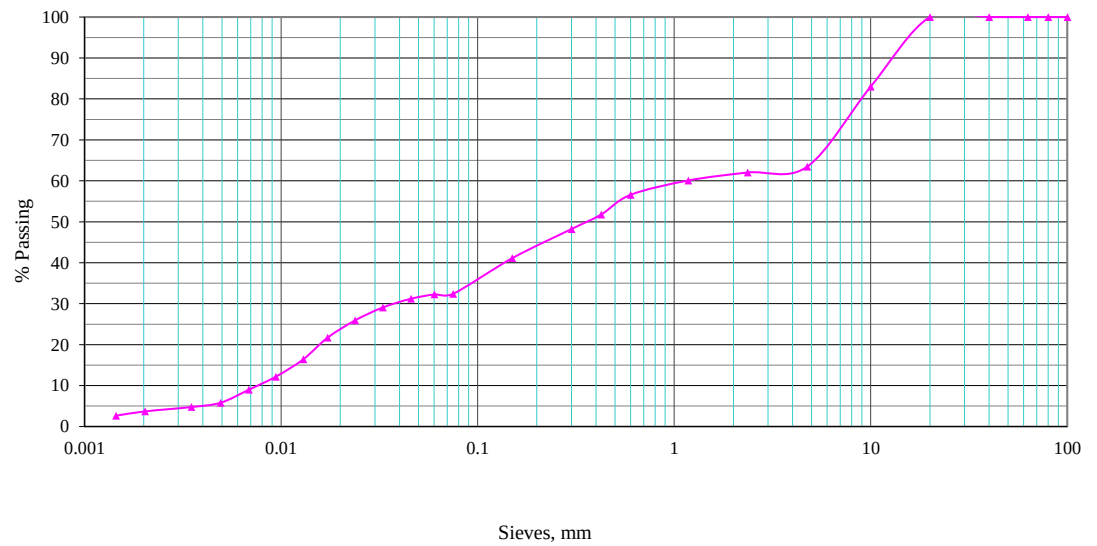
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0072	0.02	0.06	0.17
C _u	23.61	C _c	0.33

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Kaski

Bore Hole : 1
Sample : SPT
Total Wt. (gm) 174.50
Depth (m): 3.0

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	29.630	29.630	16.980	83.02
4.750	34.120	63.750	36.533	63.47
2.360	2.500	66.250	37.966	62.03
1.180	3.400	69.650	39.914	60.09
0.600	6.100	75.750	43.410	56.59
0.425	8.400	84.150	48.223	51.78
0.300	6.200	90.350	51.777	48.22
0.150	12.400	102.750	58.883	41.12
0.075	15.200	117.950	67.593	32.41
0.060				32.26
0.046				31.20
0.033				29.08
0.024				25.91
0.017				21.68
0.013				16.39
0.009				12.16
0.007				8.99
0.005				5.82
0.003				4.76
0.002				3.70
0.001				2.64



CLAY	SILT	SAND	GRAVEL
3.70 %	28.71 %	31.06 %	36.53 %

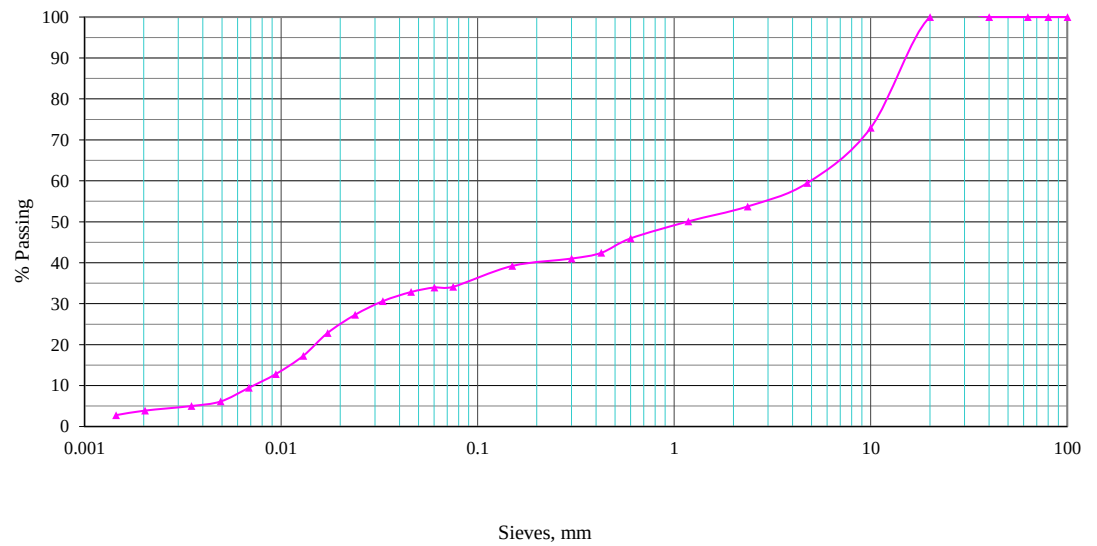
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0077	0.04	0.36	1.17
C _u	C _c		
151.95	C _c		0.18

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Kaski

Bore Hole : 1
Sample : SPT
Total Wt. (gm) 178.40
Depth (m): 4.5

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	48.230	48.230	27.035	72.97
4.750	24.100	72.330	40.544	59.46
2.360	10.200	82.530	46.261	53.74
1.180	6.500	89.030	49.905	50.10
0.600	7.400	96.430	54.053	45.95
0.425	6.300	102.730	57.584	42.42
0.300	2.500	105.230	58.985	41.01
0.150	3.200	108.430	60.779	39.22
0.075	9.100	117.530	65.880	34.12
0.060				33.96
0.046				32.85
0.033				30.62
0.024				27.28
0.017				22.83
0.013				17.26
0.009				12.81
0.007				9.46
0.005				6.12
0.003				5.01
0.002				3.90
0.001				2.78



CLAY	SILT	SAND	GRAVEL
3.90 %	30.22 %	25.34 %	40.54 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0073	0.03	1.17	4.96
C _u	C _c		
679.45	C _c		0.02

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

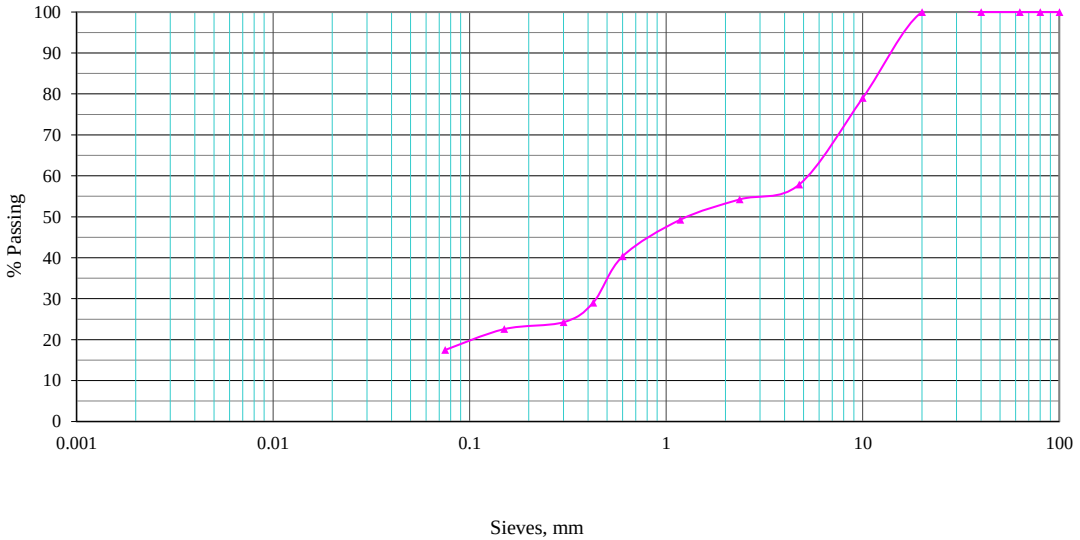
Location : Kaski

Bore Hole : 1

Sample : SPT

Depth (m): 6.0

Total Wt. (gm)	125.40
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CLAY	SILT	SAND	GRAVEL
0.00 %	17.47 %	40.40 %	42.13 %

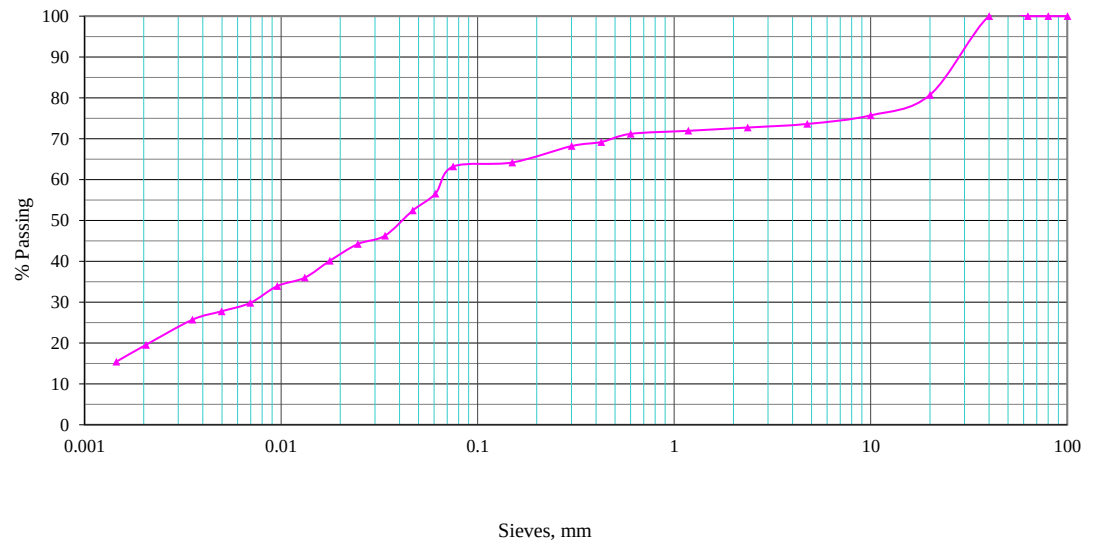
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0429	0.44	1.35	5.28
C _U	123.08	C _C	0.85

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Damauli, Tanahun

Bore Hole : 3
Sample : Disturbed
Depth (m): 1
Total Wt. (gm) 200.00

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	38.560	38.560	19.280	80.72
10.000	10.000	48.560	24.280	75.72
4.750	4.200	52.760	26.380	73.62
2.360	1.750	54.510	27.255	72.75
1.180	1.600	56.110	28.055	71.95
0.600	1.500	57.610	28.805	71.20
0.425	4.000	61.610	30.805	69.20
0.300	2.000	63.610	31.805	68.20
0.150	8.000	71.610	35.805	64.20
0.075	2.000	73.610	36.805	63.20
0.061				56.56
0.047				52.45
0.034				46.28
0.025				44.22
0.018				40.11
0.013				35.99
0.010				33.94
0.007				29.82
0.005				27.77
0.004				25.71
0.002				19.54
0.001				15.43



CLAY	SILT	SAND	GRAVEL
19.54 %	43.66 %	10.43 %	26.38 %

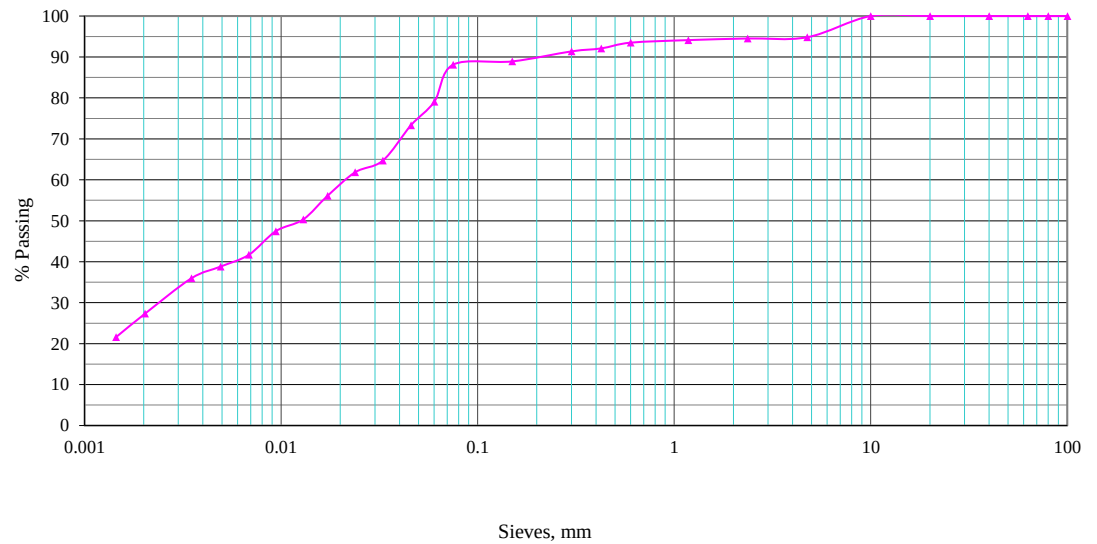
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0014	0.01	0.04	0.07
C _u	50	C _c	1.02

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Damauli, Tanahun

Bore Hole : 3
Sample : SPT
Total Wt. (gm) 200.00
Depth (m): 1.5

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	0.000	0.000	0.000	100.00
4.750	10.360	10.360	5.180	94.82
2.360	0.600	10.960	5.480	94.52
1.180	0.800	11.760	5.880	94.12
0.600	1.250	13.010	6.505	93.50
0.425	2.800	15.810	7.905	92.10
0.300	1.450	17.260	8.630	91.37
0.150	4.900	22.160	11.080	88.92
0.075	1.600	23.760	11.880	88.12
0.060				79.08
0.046				73.33
0.033				64.70
0.024				61.83
0.017				56.08
0.013				50.33
0.009				47.45
0.007				41.70
0.005				38.82
0.003				35.95
0.002				27.32
0.001				21.57



CLAY	SILT	SAND	GRAVEL
27.32 %	60.80 %	6.70 %	5.18 %

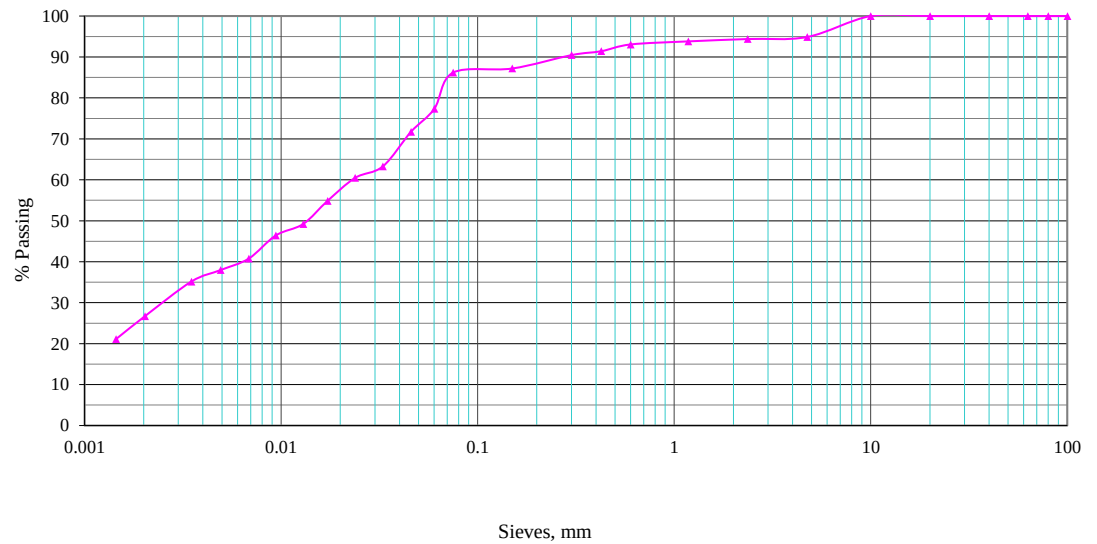
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0014	0	0.01	0.02
C _u	C _c		
14.29	0		

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Damauli, Tanahun

Bore Hole : 3
Sample : Disturbed
Depth (m): 2.0
Total Wt. (gm) 200.00

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	0.000	0.000	0.000	100.00
4.750	10.230	10.230	5.115	94.89
2.360	1.000	11.230	5.615	94.39
1.180	1.150	12.380	6.190	93.81
0.600	1.500	13.880	6.940	93.06
0.425	3.300	17.180	8.590	91.41
0.300	1.900	19.080	9.540	90.46
0.150	6.550	25.630	12.815	87.19
0.075	2.000	27.630	13.815	86.19
0.060				77.35
0.046				71.72
0.033				63.28
0.024				60.47
0.017				54.85
0.013				49.22
0.009				46.41
0.007				40.78
0.005				37.97
0.003				35.16
0.002				26.72
0.001				21.09



CLAY	SILT	SAND	GRAVEL
26.72 %	59.47 %	8.70 %	5.11 %

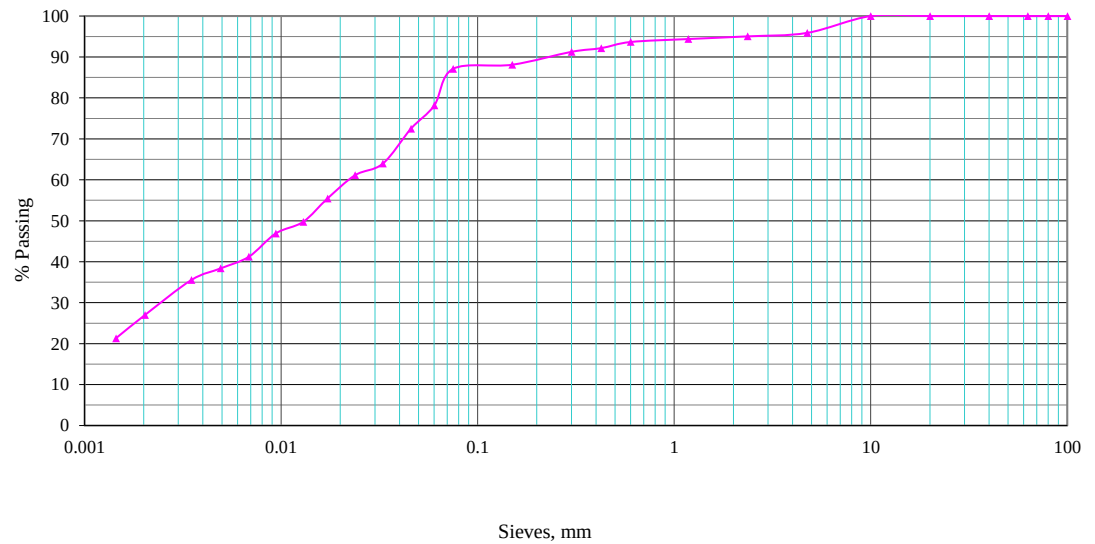
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0014	0	0.01	0.02
C _u	C _c		
	14.29		0

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Damauli, Tanahun

Bore Hole : 3
Sample : SPT
Total Wt. (gm) 200.00
Depth (m): 3.0

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	0.000	0.000	0.000	100.00
4.750	8.230	8.230	4.115	95.89
2.360	1.700	9.930	4.965	95.04
1.180	1.300	11.230	5.615	94.39
0.600	1.450	12.680	6.340	93.66
0.425	3.000	15.680	7.840	92.16
0.300	1.800	17.480	8.740	91.26
0.150	6.300	23.780	11.890	88.11
0.075	2.000	25.780	12.890	87.11
0.060				78.18
0.046				72.49
0.033				63.96
0.024				61.12
0.017				55.43
0.013				49.75
0.009				46.91
0.007				41.22
0.005				38.38
0.003				35.53
0.002				27.01
0.001				21.32



CLAY	SILT	SAND	GRAVEL
27.01 %	60.10 %	8.78 %	4.11 %

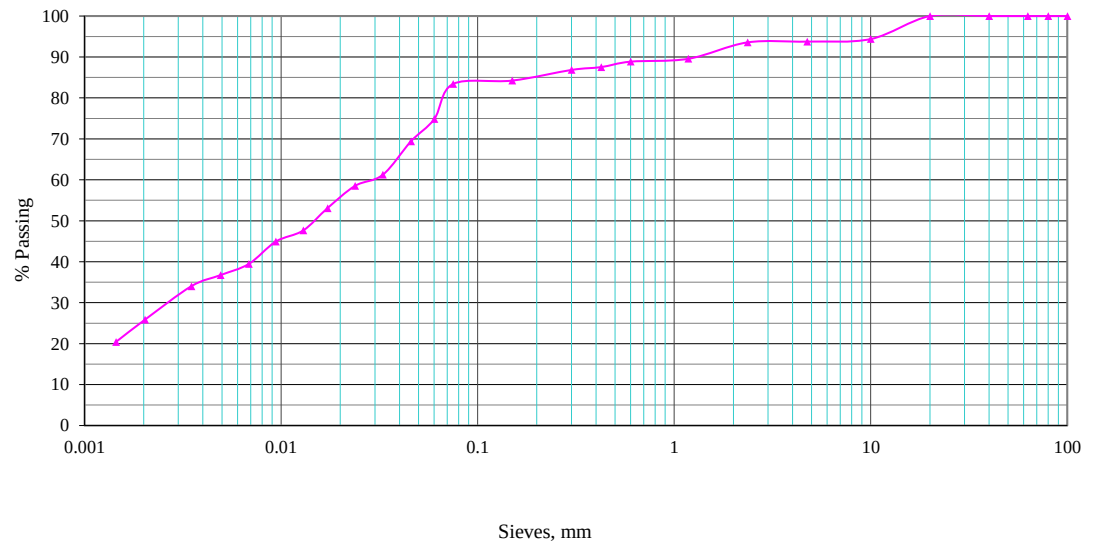
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0014	0	0.01	0.02
C _u	C _c		
	14.29		0

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Damauli, Tanahun

Bore Hole : 3
Sample : SPT
Total Wt. (gm) 200.00
Depth (m): 3.0

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	11.230	11.230	5.615	94.39
4.750	1.250	12.480	6.240	93.76
2.360	0.400	12.880	6.440	93.56
1.180	8.000	20.880	10.440	89.56
0.600	1.400	22.280	11.140	88.86
0.425	2.650	24.930	12.465	87.54
0.300	1.400	26.330	13.165	86.84
0.150	5.200	31.530	15.765	84.24
0.075	1.650	33.180	16.590	83.41
0.060				74.86
0.046				69.41
0.033				61.25
0.024				58.52
0.017				53.08
0.013				47.64
0.009				44.91
0.007				39.47
0.005				36.75
0.003				34.03
0.002				25.86
0.001				20.42



CLAY	SILT	SAND	GRAVEL
25.86 %	57.55 %	10.35 %	6.24 %

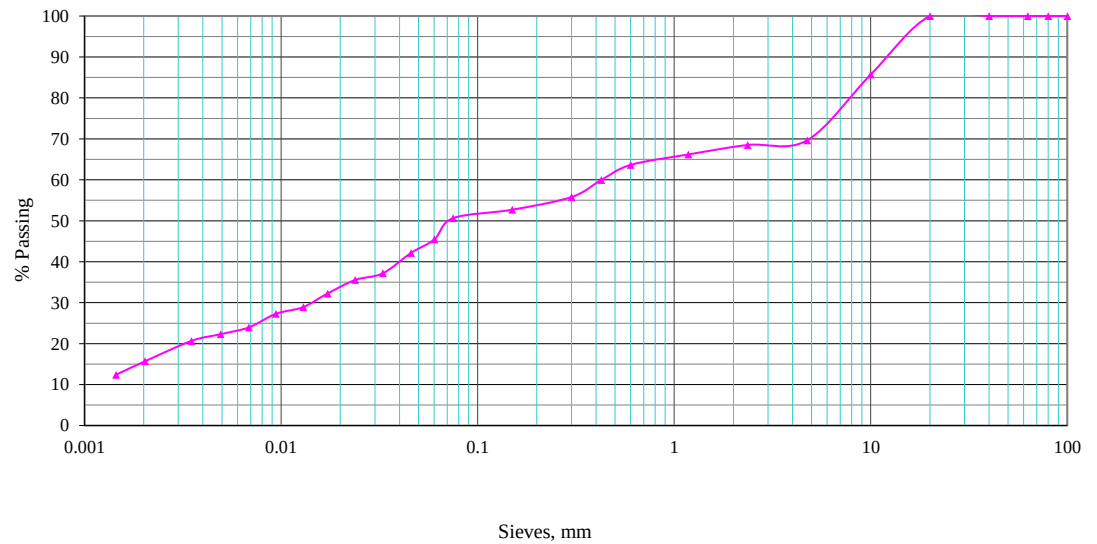
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0014	0	0.01	0.03
C _u	21.43	C _c	0

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Damauli, Tanahun

Bore Hole : 3
Sample : Disturbed
Total Wt. (gm) 200.00
Depth (m): 6.0

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	28.560	28.560	14.280	85.72
4.750	32.120	60.680	30.340	69.66
2.360	2.300	62.980	31.490	68.51
1.180	4.620	67.600	33.800	66.20
0.600	5.100	72.700	36.350	63.65
0.425	7.400	80.100	40.050	59.95
0.300	8.300	88.400	44.200	55.80
0.150	6.200	94.600	47.300	52.70
0.075	4.120	98.720	49.360	50.64
0.060				45.45
0.046				42.14
0.033				37.18
0.024				35.53
0.017				32.23
0.013				28.92
0.009				27.27
0.007				23.96
0.005				22.31
0.003				20.66
0.002				15.70
0.001				12.39



CLAY	SILT	SAND	GRAVEL
15.70 %	34.94 %	19.02 %	30.34 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0014	0.01	0.07	0.43
C _u	C _c		
307.14	0.17		

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

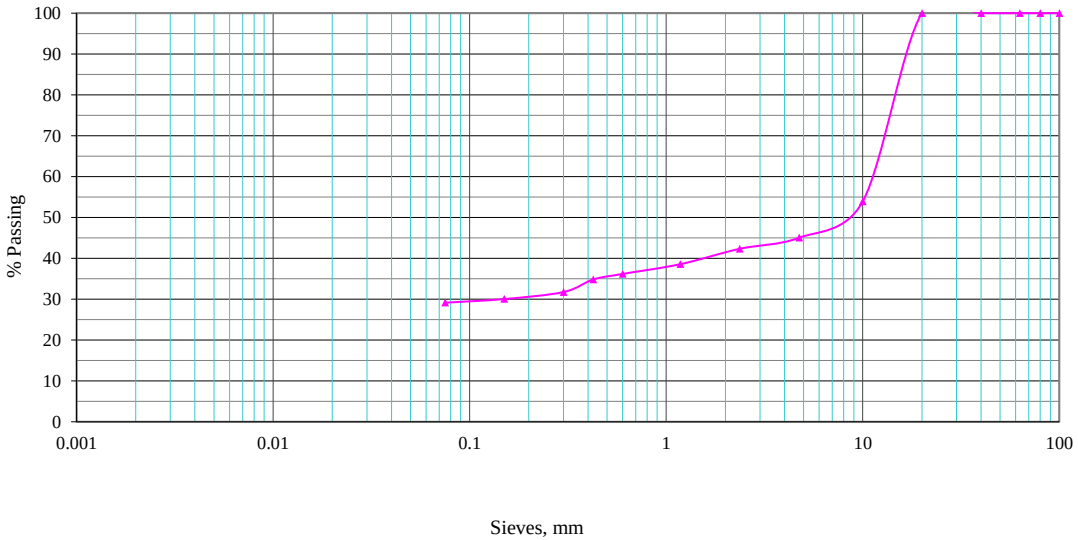
Location : Sishaghat

Bore Hole : 4

Sample : SPT

Depth (m): 1.5

Total Wt. (gm)	146.50
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	29.15 %	15.90 %	54.95 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0257	0.15	7.68	21.87
C _U	850.97	C _C	0.04

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

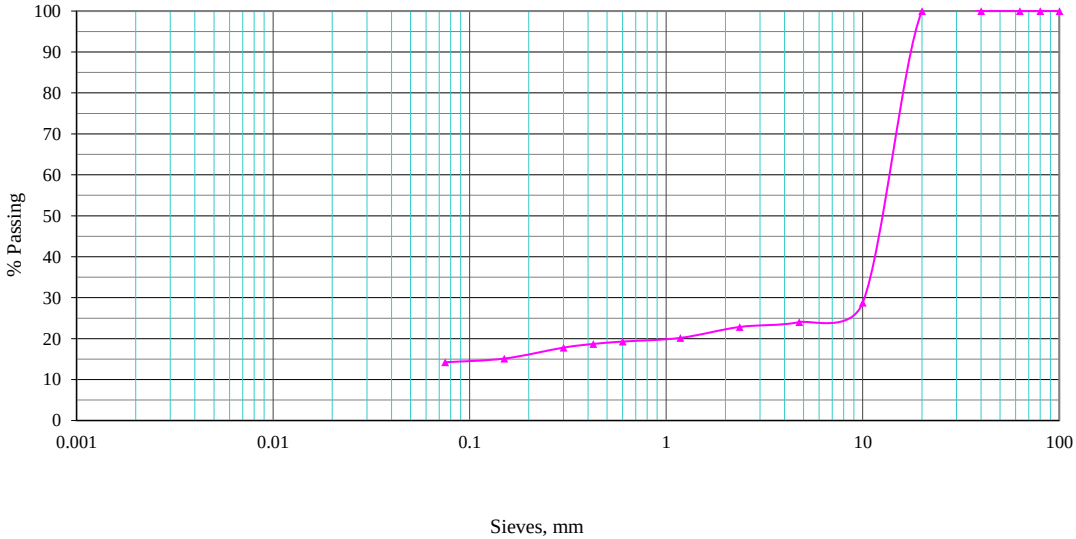
Location : Sishaghat

Bore Hole : 4

Sample : SPT

Depth (m): 3.0

Total Wt. (gm)	168.50
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	14.24 %	9.79 %	75.96 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0527	11.54	36.81	49.45
C _U	938.33	C _C	51.1

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

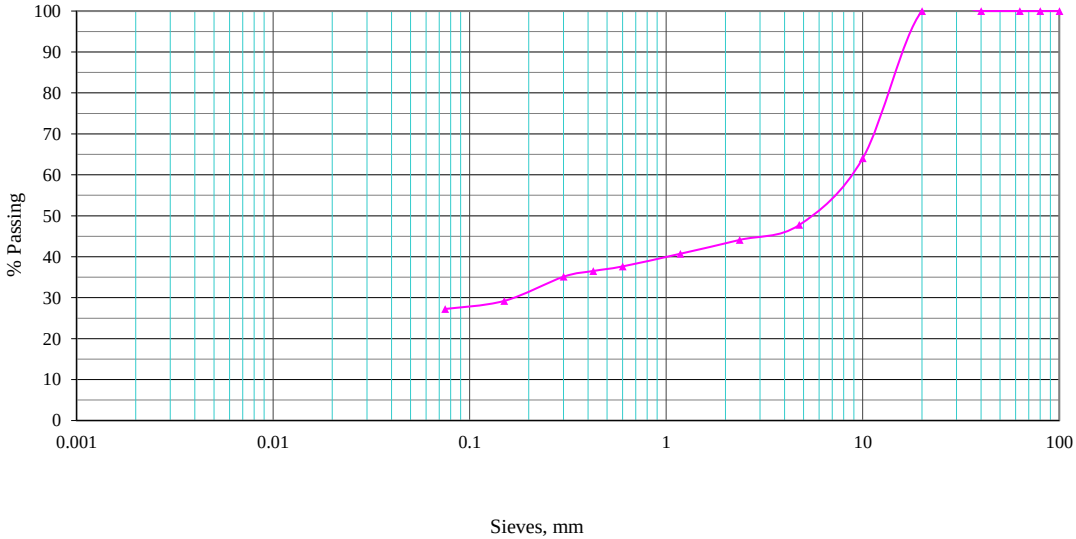
Location : Sishaghat

Bore Hole : 4

Sample : SPT

Depth (m): 4.5

Total Wt. (gm)	178.00
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	27.25 %	20.51 %	52.25 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0275	0.17	5.47	8.7
C _U	316.36	C _C	0.12

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

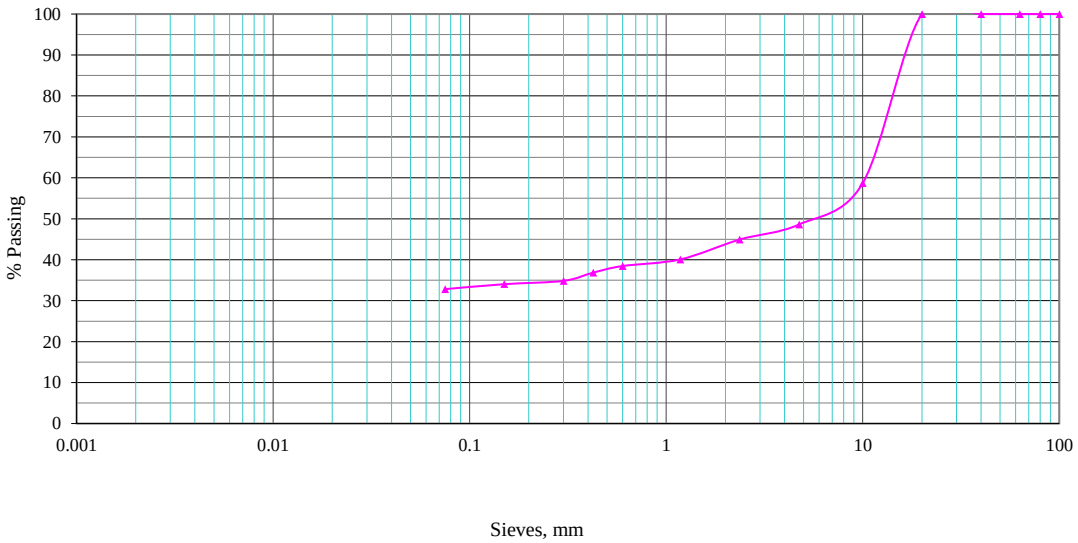
Location : Sishaghat

Bore Hole : 4

Sample : SPT

Depth (m): 6.0

Total Wt. (gm)	124.00
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	32.82 %	15.81 %	51.37 %

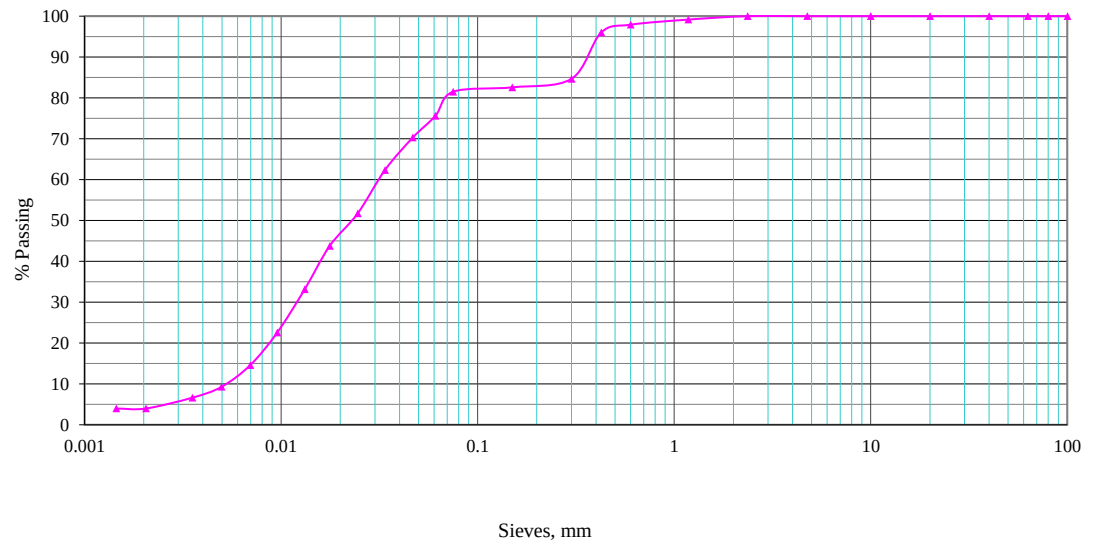
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0229	0.07	5.46	12.81
C _U	559.39	C _C	0.02

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Ranibari, Damauli, Tanahun

Bore Hole : 5
Sample : SPT
Total Wt. (gm) 120.00
Depth (m): 1.5

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	0.000	0.000	0.000	100.00
4.750	0.000	0.000	0.000	100.00
2.360	0.000	0.000	0.000	100.00
1.180	1.000	1.000	0.833	99.17
0.600	1.500	2.500	2.083	97.92
0.425	2.300	4.800	4.000	96.00
0.300	13.600	18.400	15.333	84.67
0.150	2.500	20.900	17.417	82.58
0.075	1.300	22.200	18.500	81.50
0.061				75.60
0.047				70.29
0.034				62.34
0.025				51.73
0.018				43.77
0.013				33.16
0.010				22.55
0.007				14.59
0.005				9.28
0.004				6.63
0.002				3.98
0.001				3.98



CLAY	SILT	SAND	GRAVEL
3.98 %	77.52 %	18.50 %	0.00 %

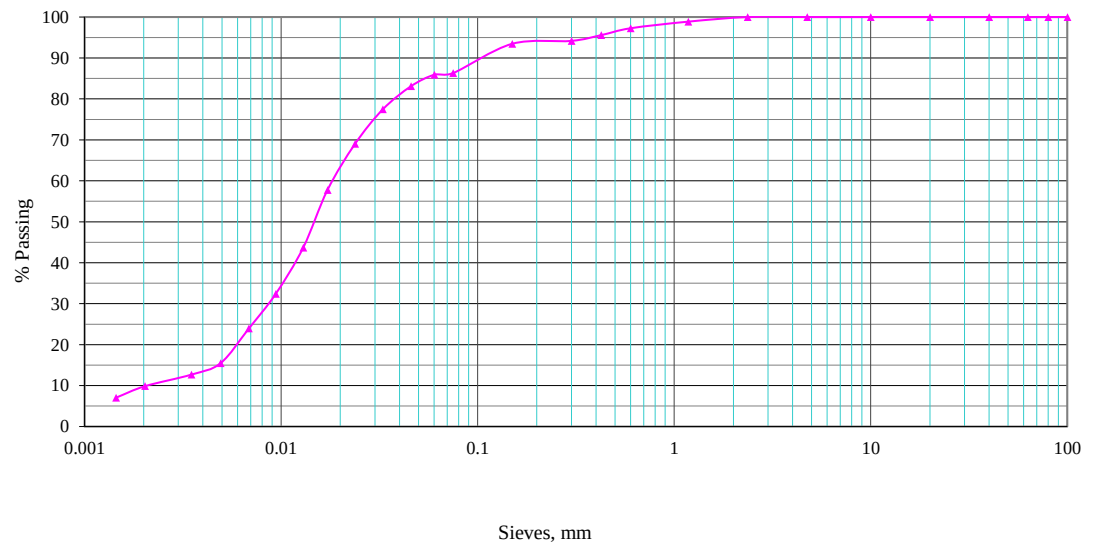
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0052	0.01	0.02	0.03
C _u	5.77	C _c	0.64

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Damauli, Tanahun

Bore Hole : 5
Sample : SPT
Total Wt. (gm) 142.50
Depth (m): 3.0

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	0.000	0.000	0.000	100.00
4.750	0.000	0.000	0.000	100.00
2.360	0.000	0.000	0.000	100.00
1.180	1.600	1.600	1.123	98.88
0.600	2.300	3.900	2.737	97.26
0.425	2.400	6.300	4.421	95.58
0.300	2.000	8.300	5.825	94.18
0.150	1.000	9.300	6.526	93.47
0.075	10.200	19.500	13.684	86.32
0.060				85.91
0.046				83.10
0.033				77.46
0.024				69.01
0.017				57.75
0.013				43.66
0.009				32.39
0.007				23.94
0.005				15.49
0.003				12.68
0.002				9.86
0.001				7.04



CLAY	SILT	SAND	GRAVEL
9.86 %	76.46 %	13.68 %	0.00 %

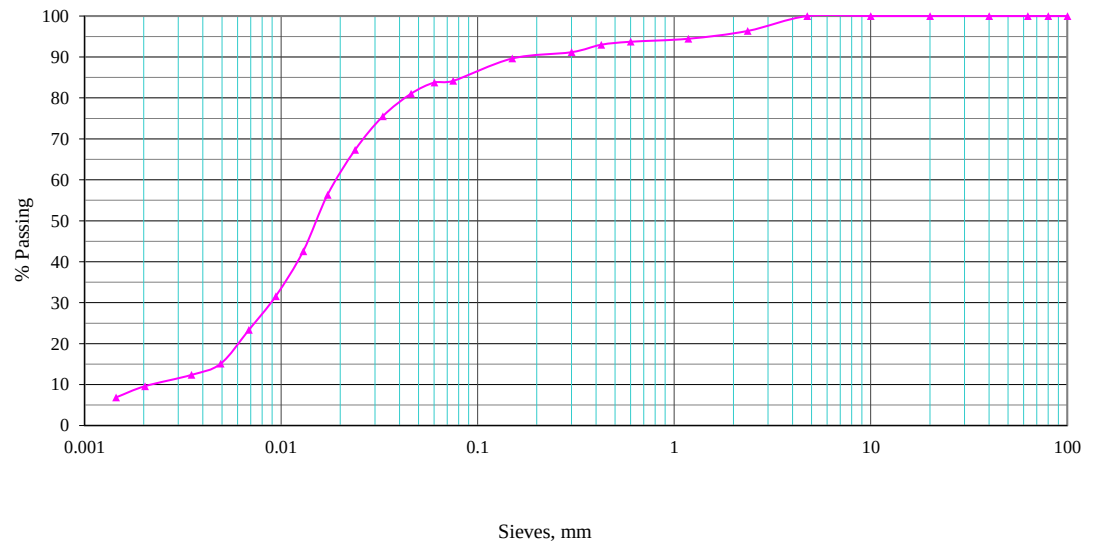
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0021	0.01	0.01	0.02
C _u	9.52	C _c	2.38

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Damauli, Tanahun

Bore Hole : 5
Sample : SPT
Total Wt. (gm) 137.00
Depth (m): 4.5

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	0.000	0.000	0.000	100.00
4.750	0.000	0.000	0.000	100.00
2.360	5.000	5.000	3.650	96.35
1.180	2.600	7.600	5.547	94.45
0.600	1.000	8.600	6.277	93.72
0.425	1.000	9.600	7.007	92.99
0.300	2.500	12.100	8.832	91.17
0.150	2.100	14.200	10.365	89.64
0.075	7.500	21.700	15.839	84.16
0.060				83.77
0.046				81.02
0.033				75.53
0.024				67.29
0.017				56.30
0.013				42.57
0.009				31.58
0.007				23.35
0.005				15.11
0.003				12.36
0.002				9.61
0.001				6.87



CLAY	SILT	SAND	GRAVEL
9.61 %	74.55 %	15.84 %	0.00 %

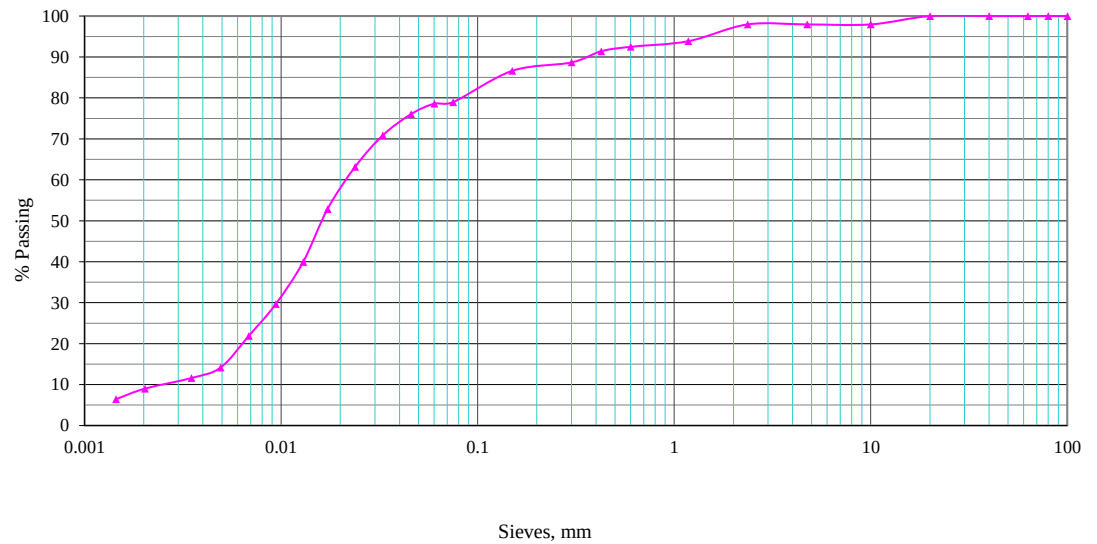
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0022	0.01	0.02	0.02
C _u	C _c		
9.09	2.27		

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Damauli, Tanahun

Bore Hole : 5
Sample : SPT
Total Wt. (gm) 146.50
Depth (m): 6.0

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	3.000	3.000	2.048	97.95
4.750	0.000	3.000	2.048	97.95
2.360	0.000	3.000	2.048	97.95
1.180	6.000	9.000	6.143	93.86
0.600	2.000	11.000	7.509	92.49
0.425	1.600	12.600	8.601	91.40
0.300	4.000	16.600	11.331	88.67
0.150	3.000	19.600	13.379	86.62
0.075	11.200	30.800	21.024	78.98
0.060				78.61
0.046				76.03
0.033				70.88
0.024				63.14
0.017				52.84
0.013				39.95
0.009				29.64
0.007				21.91
0.005				14.18
0.003				11.60
0.002				9.02
0.001				6.44



CLAY	SILT	SAND	GRAVEL
9.02 %	69.96 %	18.98 %	2.05 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0026	0.01	0.02	0.02
C _U	7.69	C _C	1.92

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Damauli, Tanahun

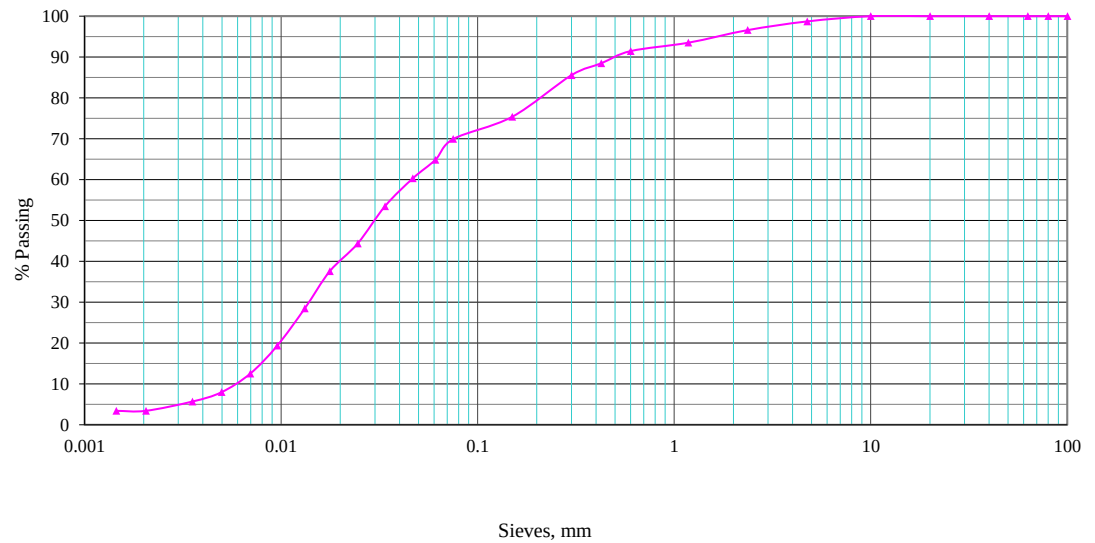
Bore Hole : 7

Sample : SPT

Depth (m): 1.5

Total Wt. (gm) 117.00

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	0.000	0.000	0.000	100.00
4.750	1.500	1.500	1.282	98.72
2.360	2.500	4.000	3.419	96.58
1.180	3.600	7.600	6.496	93.50
0.600	2.400	10.000	8.547	91.45
0.425	3.500	13.500	11.538	88.46
0.300	3.400	16.900	14.444	85.56
0.150	11.900	28.800	24.615	75.38
0.075	6.400	35.200	30.085	69.91
0.061				64.85
0.047				60.30
0.034				53.47
0.025				44.37
0.018				37.55
0.013				28.44
0.010				19.34
0.007				12.52
0.005				7.96
0.004				5.69
0.002				3.41
0.001				3.41



CLAY	SILT	SAND	GRAVEL
3.41 %	66.50 %	28.80 %	1.28 %

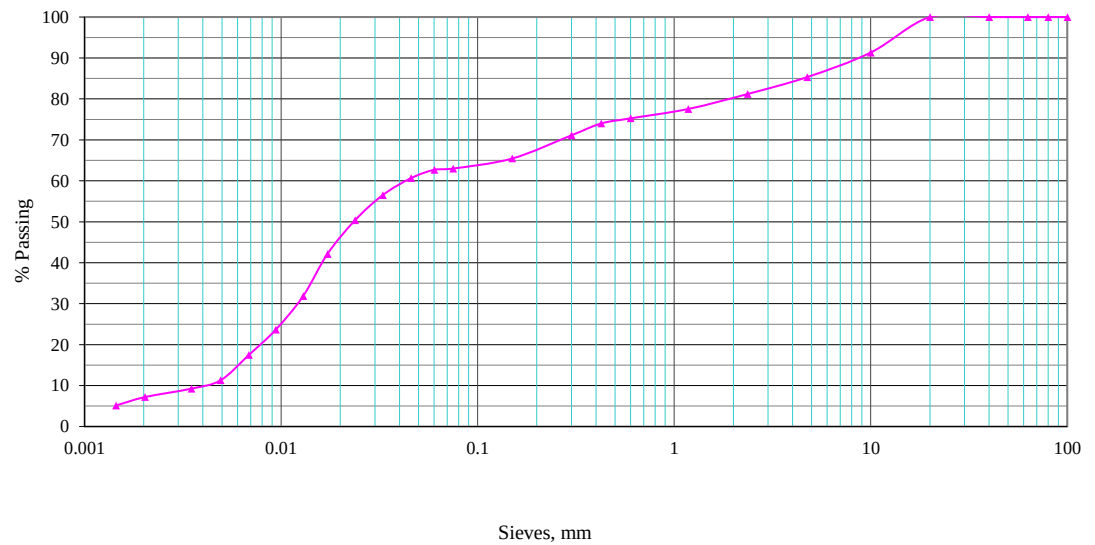
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0059	0.01	0.03	0.05
C _u	8.47	C _c	0.34

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Damauli, Tanahun

Bore Hole : 7
Sample : SPT
Total Wt. (gm) 183.50
Depth (m): 3.0

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	15.900	15.900	8.665	91.34
4.750	11.000	26.900	14.659	85.34
2.360	7.600	34.500	18.801	81.20
1.180	6.700	41.200	22.452	77.55
0.600	4.200	45.400	24.741	75.26
0.425	2.300	47.700	25.995	74.01
0.300	5.300	53.000	28.883	71.12
0.150	10.400	63.400	34.550	65.45
0.075	4.500	67.900	37.003	63.00
0.060				62.70
0.046				60.65
0.033				56.54
0.024				50.37
0.017				42.15
0.013				31.87
0.009				23.64
0.007				17.47
0.005				11.31
0.003				9.25
0.002				7.20
0.001				5.14



CLAY	SILT	SAND	GRAVEL
7.20 %	55.80 %	22.34 %	14.66 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.004	0.01	0.02	0.04
C _u	10	C _c	0.63

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
Location : Damauli, Tanahun

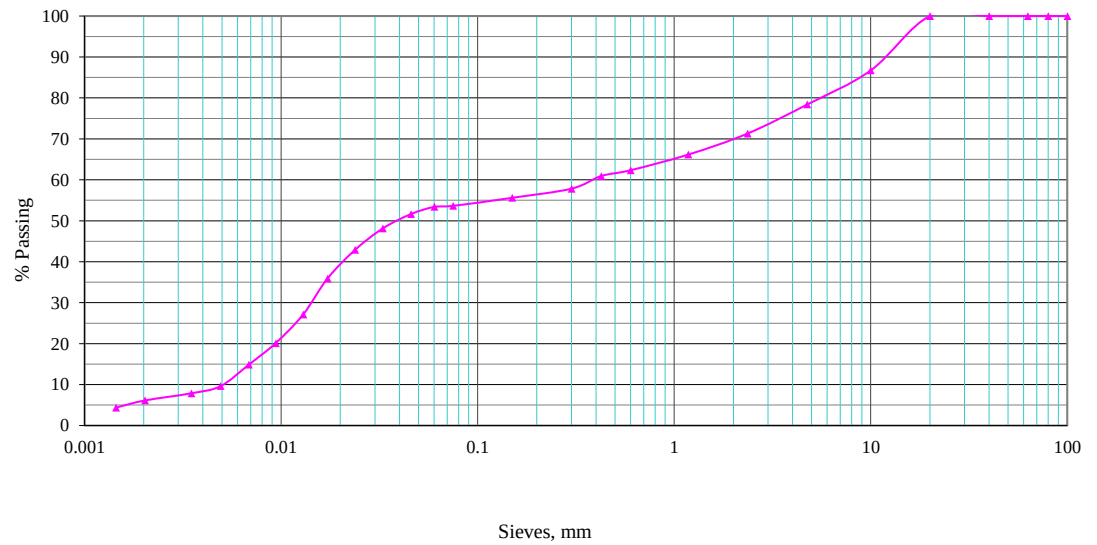
Bore Hole : 7

Sample : SPT

Depth (m): 4.5

Total Wt. (gm) 162.00

Sieve (mm)	Weight Retained (gm)	Cum.Wt. Retained (gm)	Cum. Wt. Retained %	% Passing
100.000	0.000	0.000	0.000	100.00
80.000	0.000	0.000	0.000	100.00
63.000	0.000	0.000	0.000	100.00
40.000	0.000	0.000	0.000	100.00
20.000	0.000	0.000	0.000	100.00
10.000	21.500	21.500	13.272	86.73
4.750	13.500	35.000	21.605	78.40
2.360	11.500	46.500	28.704	71.30
1.180	8.300	54.800	33.827	66.17
0.600	6.200	61.000	37.654	62.35
0.425	2.300	63.300	39.074	60.93
0.300	5.000	68.300	42.160	57.84
0.150	3.600	71.900	44.383	55.62
0.075	3.200	75.100	46.358	53.64
0.060				53.39
0.046				51.64
0.033				48.14
0.024				42.89
0.017				35.89
0.013				27.13
0.009				20.13
0.007				14.88
0.005				9.63
0.003				7.88
0.002				6.13
0.001				4.38



CLAY	SILT	SAND	GRAVEL
6.13 %	47.51 %	24.75 %	21.60 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0051	0.01	0.04	0.39
C _u	C _c		
	76.47		0.05

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

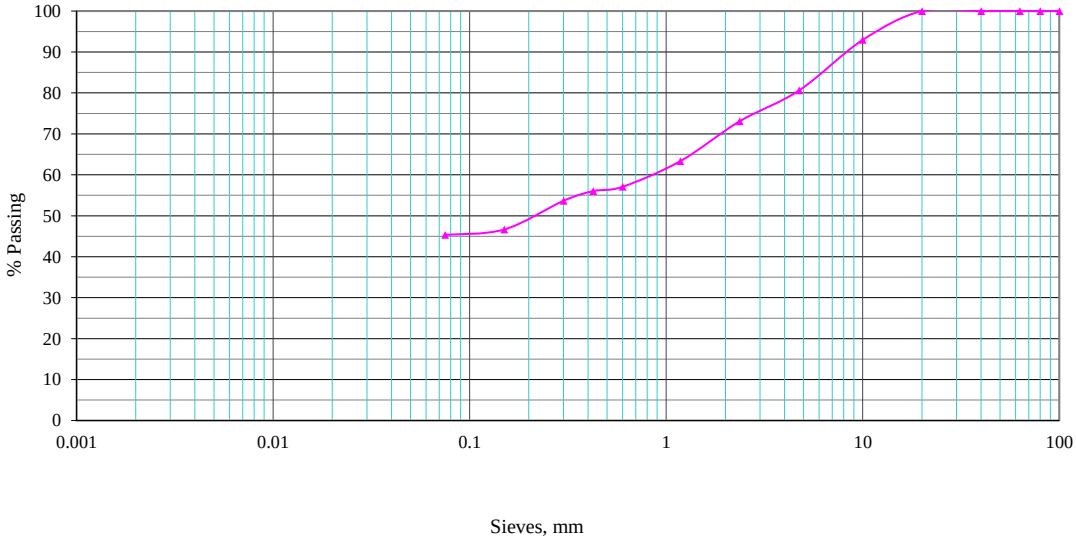
Location : Damauli, Tanahun

Bore Hole : 7

Sample : SPT

Depth (m): 6.0

Total Wt. (gm)	191.50
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	45.35 %	35.28 %	19.37 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0165	0.05	0.22	0.87
C _U	52.73	C _C	0.17

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

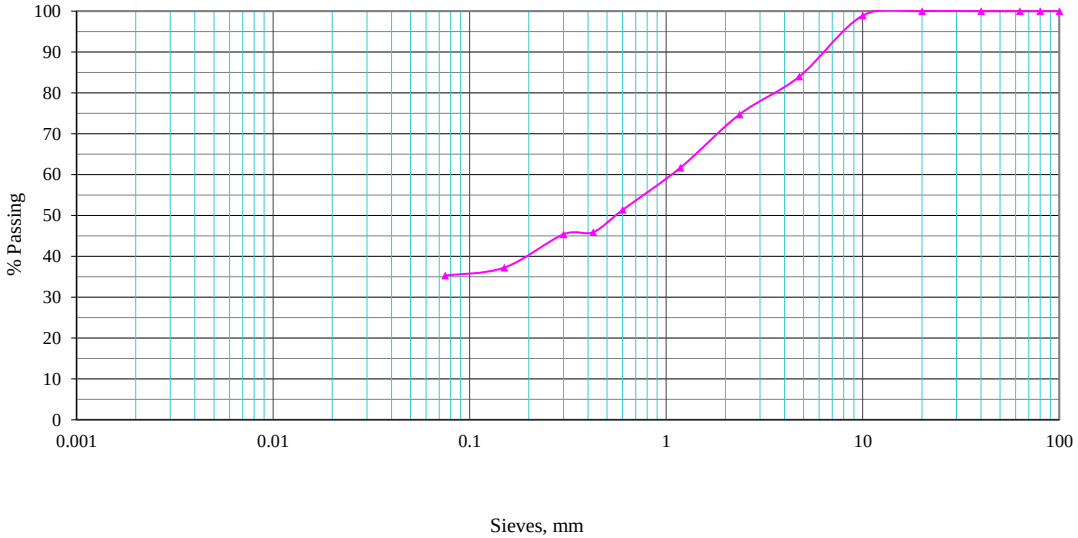
Location : Damauli, Tanahun

Bore Hole : 8 - DAMAULI SUBSTATION

Sample : SPT

Depth (m): 1.5

Total Wt. (gm)	184.00
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	35.33 %	48.64 %	16.03 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0212	0.06	0.56	1.09
C _U	51.42	C _C	0.16

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

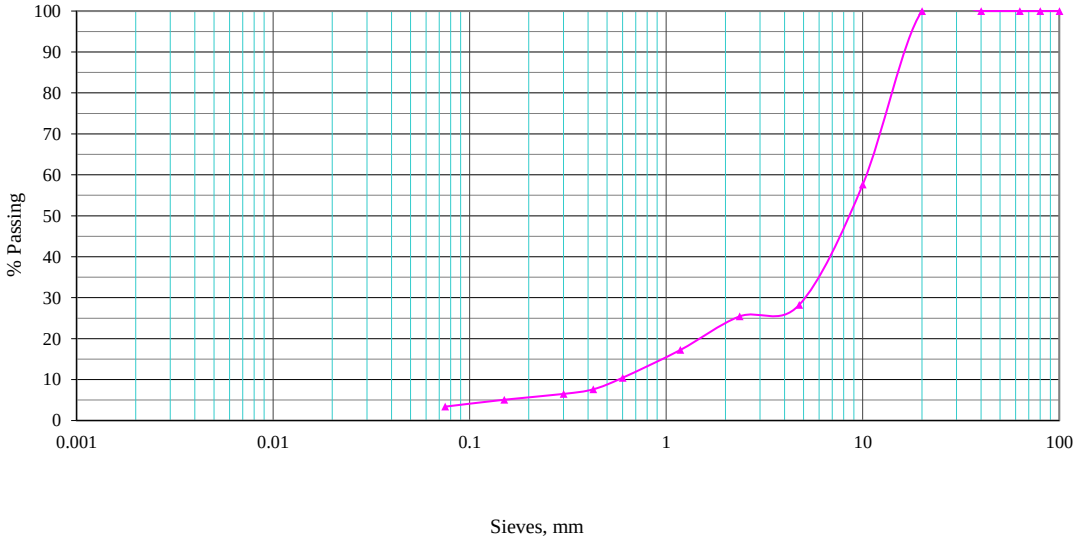
Location : Damauli, Tanahun

Bore Hole : 8 - DAMAULI SUBSTATION

Sample : SPT

Depth (m): 3.0

Total Wt. (gm)	177.00
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	3.39 %	24.86 %	71.75 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.572	5.06	8.64	15.04
C _U	26.29	C _C	2.98

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

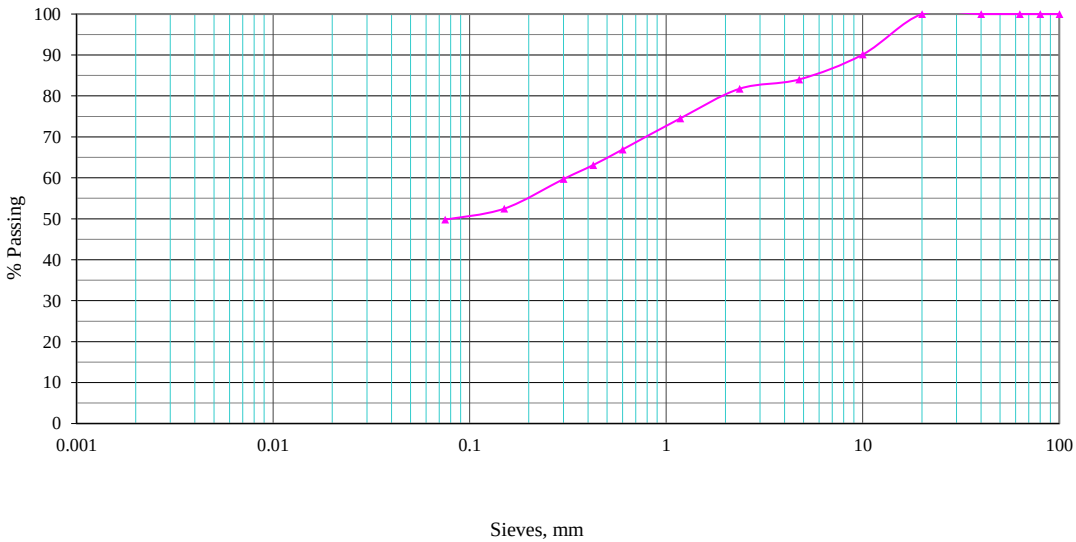
Location : Damauli, Tanahun

Bore Hole : 8 - DAMAULI SUBSTATION

Sample : SPT

Depth (m): 4.5

Total Wt. (gm)	131.50
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	49.81 %	34.22 %	15.97 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0151	0.05	0.08	0.31
C _U	20.53	C _C	0.53

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

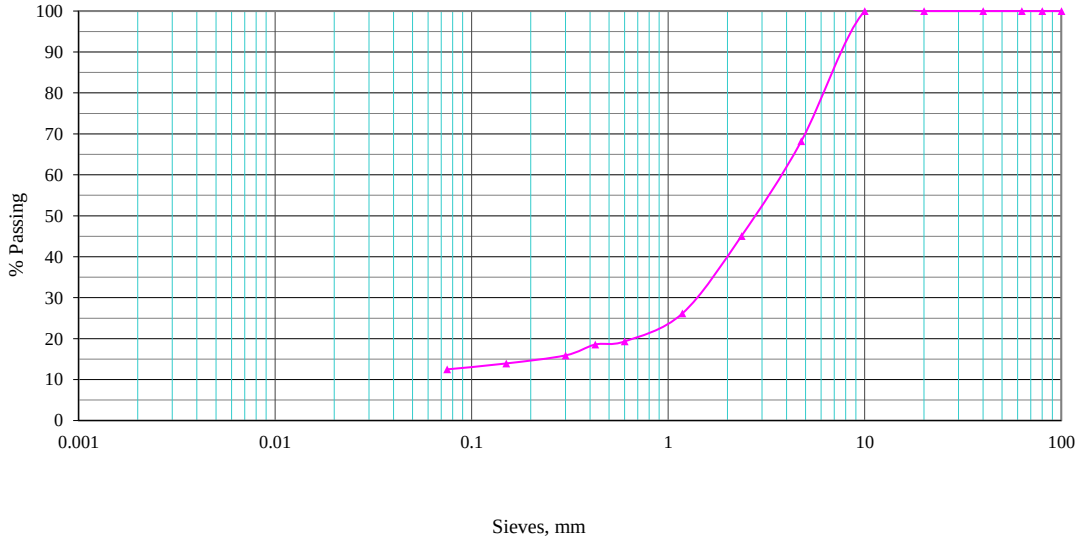
Location : Damauli, Tanahun

Bore Hole : 8 - DAMAULI SUBSTATION

Sample : SPT

Depth (m): 6.0

Total Wt. (gm)	132.00
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	12.50 %	55.68 %	31.82 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.06	1.42	2.87	3.9
C _U	65	C _C	8.62

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

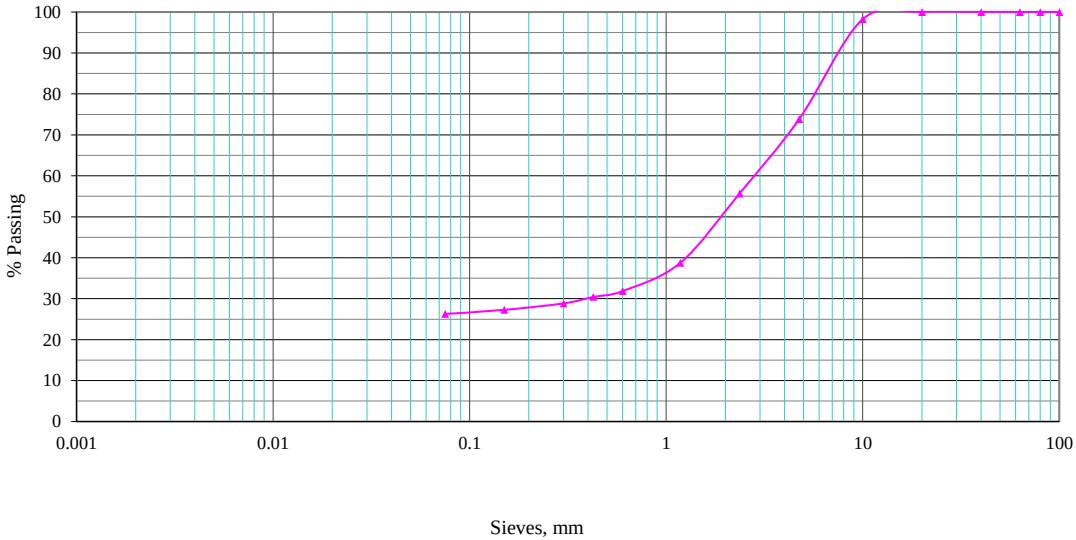
Location : Damauli, Tanahun

Bore Hole : 8 - DAMAULI SUBSTATION

Sample : SPT

Depth (m): 7.5

Total Wt. (gm)	159.50
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	26.27 %	47.59 %	26.14 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0286	0.39	1.96	2.93
C _U	102.45	C _C	1.82

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

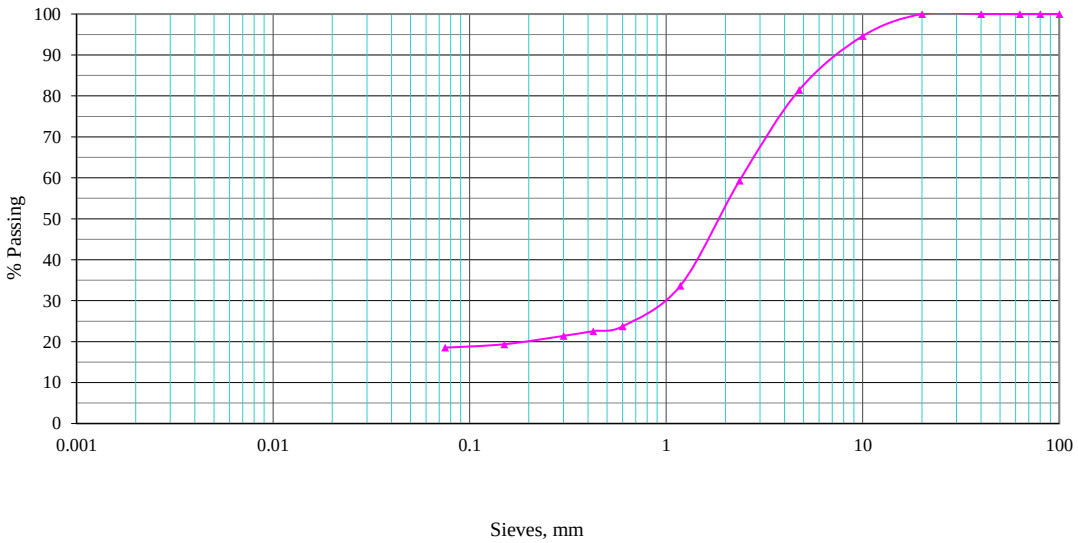
Location : Damauli, Tanahun

Bore Hole : 8 - DAMAULI SUBSTATION

Sample : SPT

Depth (m): 9.0

Total Wt. (gm)	171.50
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	18.54 %	62.92 %	18.54 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0404	0.97	1.93	2.44
C _U	60.4	C _C	9.54

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

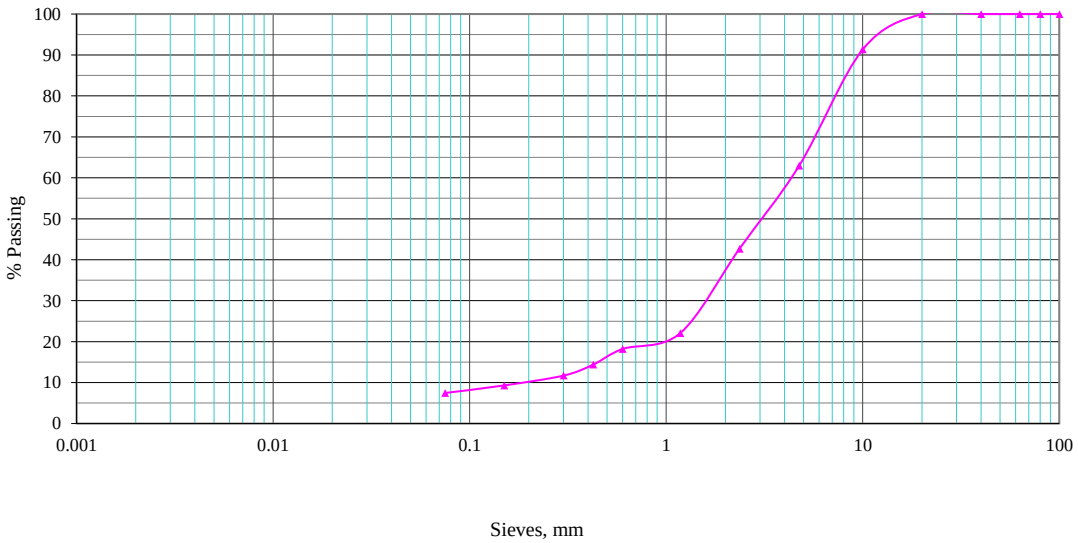
Location : Damauli, Tanahun

Bore Hole : 8 - DAMAULI SUBSTATION

Sample : SPT

Depth (m): 10.5

Total Wt. (gm)	167.50
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	7.46 %	55.52 %	37.01 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.1931	1.63	3.22	4.4
C _U	22.79	C _C	3.13

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

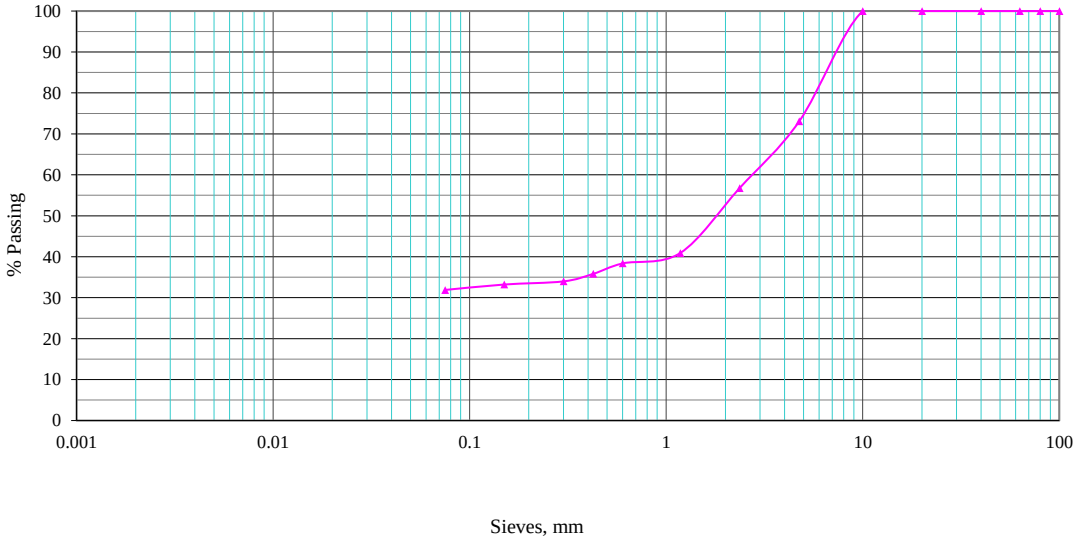
Location : Damauli, Tanahun

Bore Hole : 8 - DAMAULI SUBSTATION

Sample : SPT

Depth (m): 12.0

Total Wt. (gm)	196.00
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	31.89 %	41.17 %	26.94 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0235	0.07	1.86	2.84
C _U	120.85	C _C	0.07

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

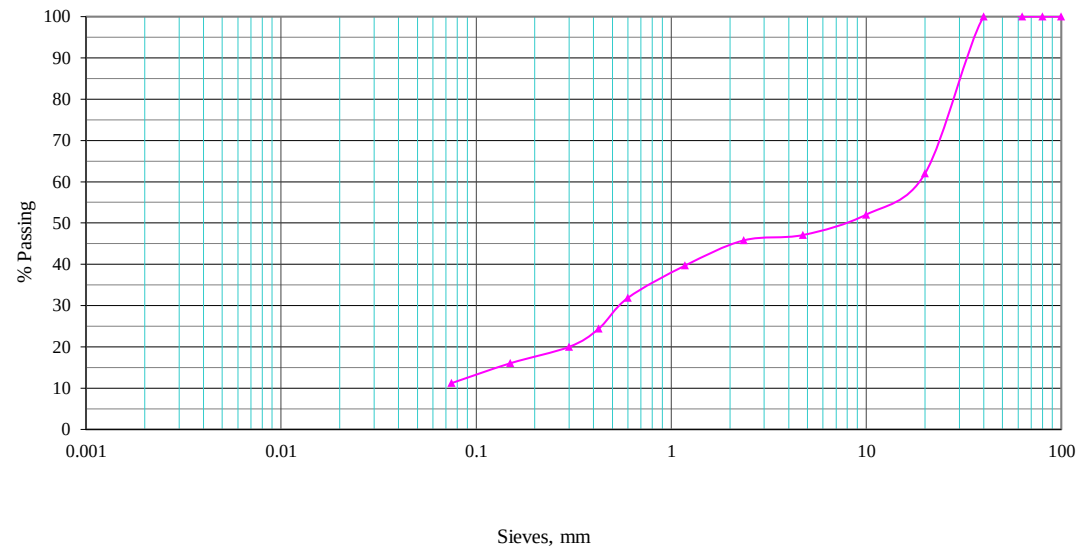
Location : Pokhara Metropolitan City, Argau, Lekhnath

Bore Hole : 9 - LEKHNATH SUBSTATION

Sample : Disturbed

Depth (m): 1.5

Total Wt. (gm)	232.55
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	11.22 %	35.88 %	52.90 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0668	0.56	7.83	18.01
C _U	269.61	C _C	0.26

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

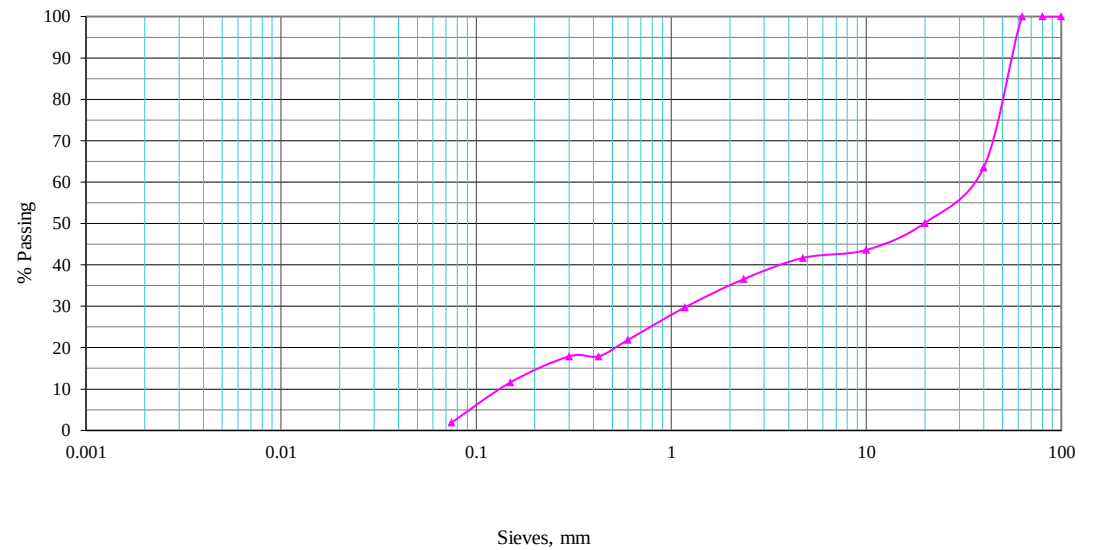
Location : Pokhara Metropolitan City, Argau, Lekhnath

Bore Hole : 9 - LEKHNATH SUBSTATION

Sample : Disturbed

Depth (m): 4.5

Total Wt. (gm)	340.63
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	1.91 %	39.78 %	58.31 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.1375	1.22	19.78	34.73
C _U	252.58	C _C	0.31

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

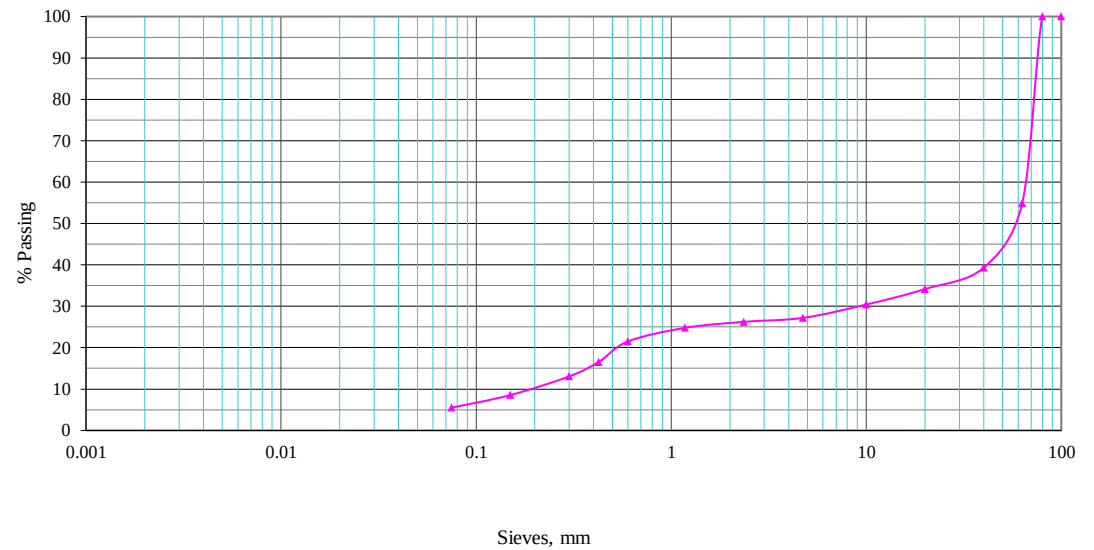
Location : Pokhara Metropolitan City, Argau, Lekhnath

Bore Hole : 9 - LEKHNATH SUBSTATION

Sample : Disturbed

Depth (m): 7.5

Total Wt. (gm)	477.22
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	5.51 %	21.69 %	72.80 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.1983	9.33	55.81	67.21
C _U	338.93	C _C	6.53

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines

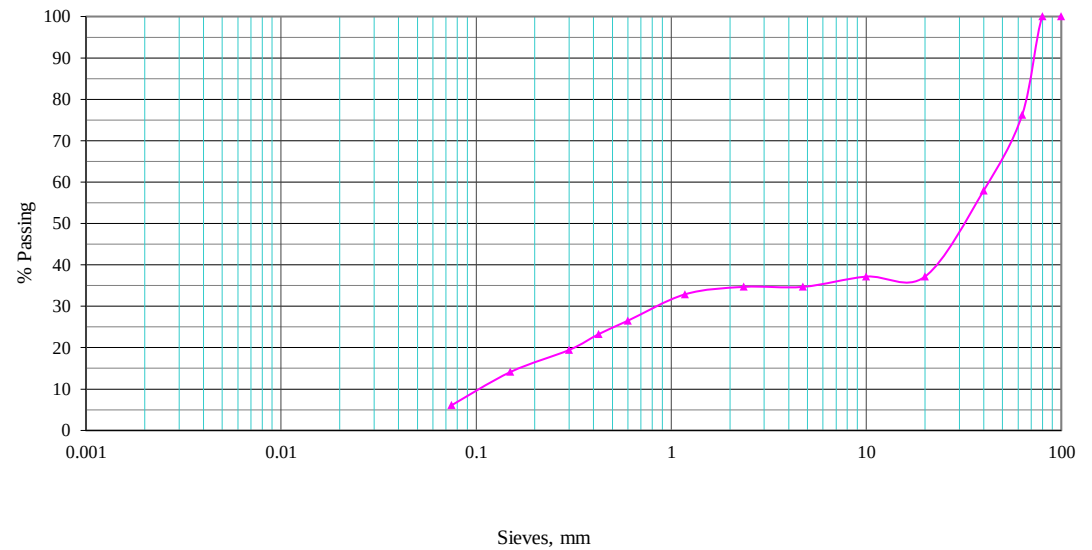
Location : Pokhara Metropolitan City, Argau, Lekhnath

Bore Hole : 9 - LEKHNATH SUBSTATION

Sample : Disturbed

Depth (m): 12.0

Total Wt. (gm)	693.70
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	6.10 %	28.59 %	65.32 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.1114	0.92	32.35	42.58
C _U	382.23	C _C	0.18

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

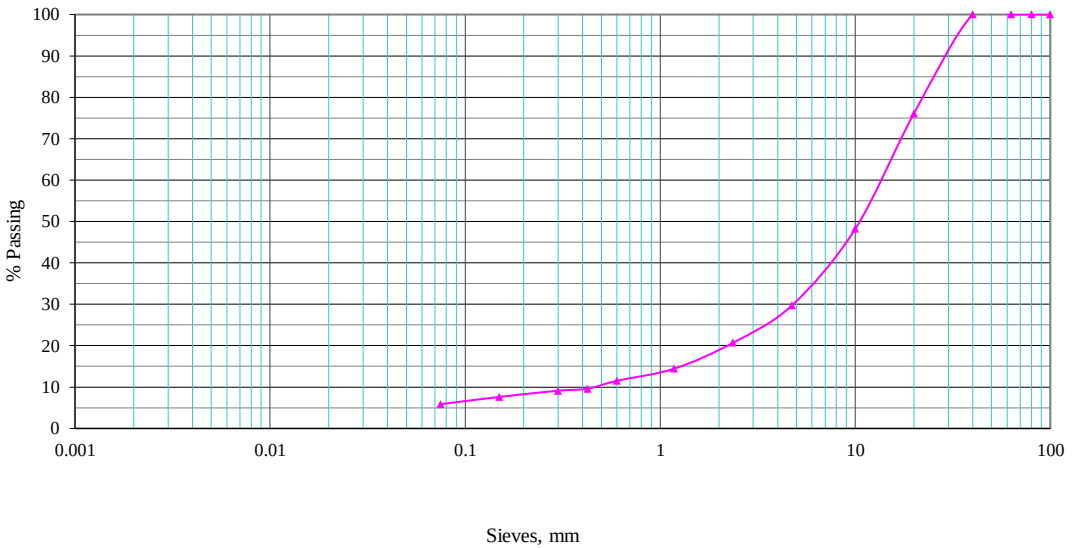
Location : Damauli, Tanahun

Bore Hole : 1

Sample : SPT

Depth (m): 1.5

Total Wt. (gm)	341.85
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	5.85 %	23.93 %	70.22 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.4609	4.81	10.65	14.23
C _U	30.87	C _C	3.53

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

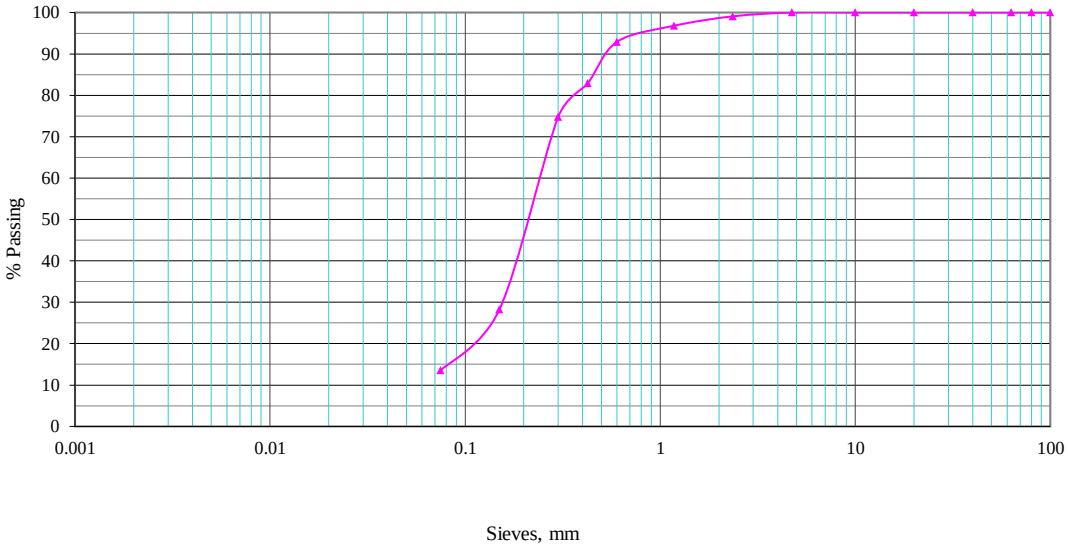
Location : Damauli, Tanahun

Bore Hole : 1

Sample : Disturbed

Depth (m): 1.5

Total Wt. (gm)	231.70
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	13.55 %	86.45 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0553	0.16	0.22	0.25
C _U	4.52	C _C	1.85

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

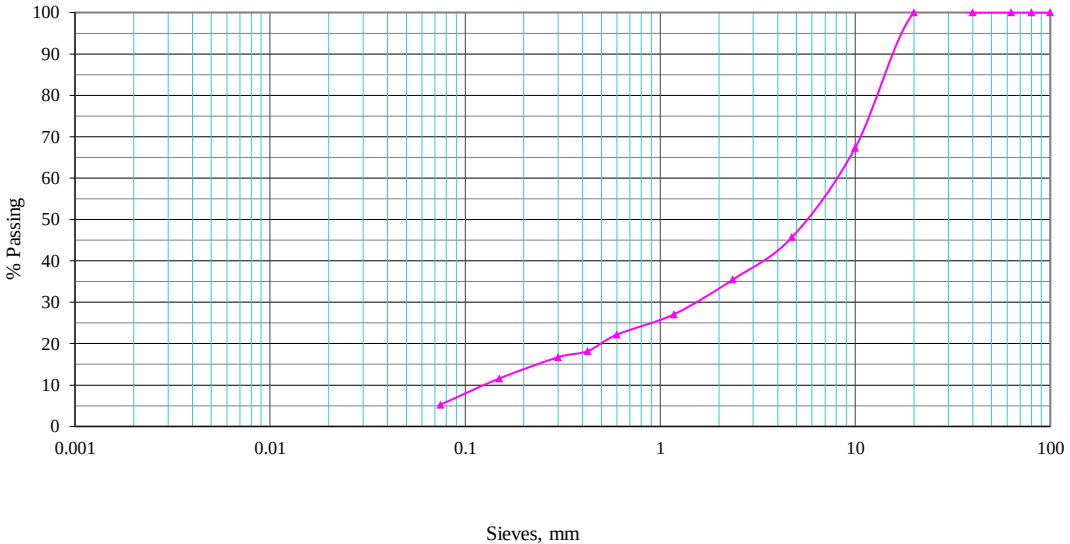
Location : Damauli, Tanahun

Bore Hole : 1

Sample : SPT

Depth (m): 3.0

Total Wt. (gm)	297.50
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	5.28 %	40.47 %	54.25 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.1311	1.59	5.78	8.21
C _U	62.62	C _C	2.35

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

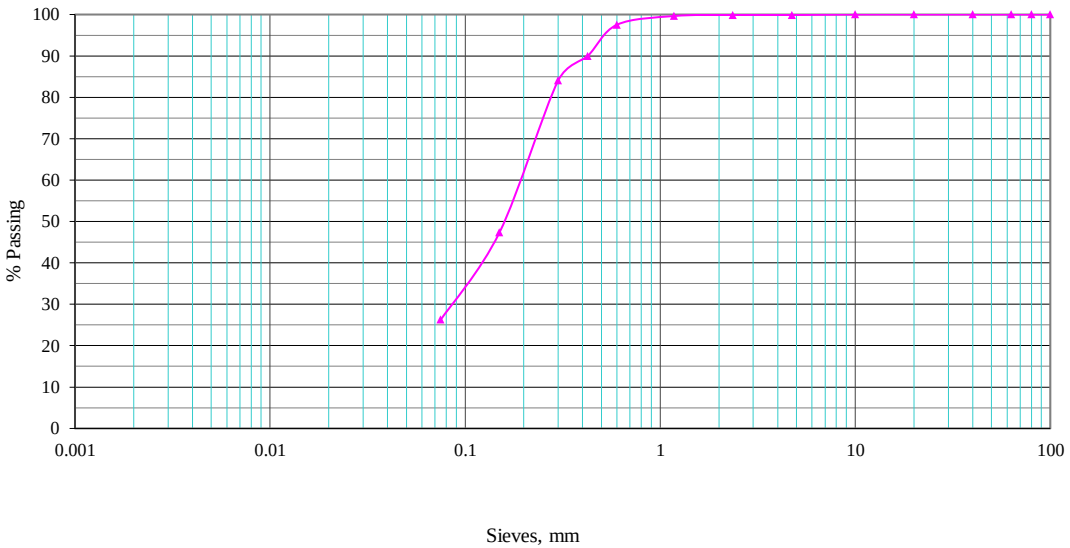
Location : Damauli, Tanahun

Bore Hole : 1

Sample : Disturbed

Depth (m): 3.0

Total Wt. (gm)	435.75
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	26.28 %	73.61 %	0.11 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0285	0.09	0.16	0.2
C _U	7.02	C _C	1.42

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

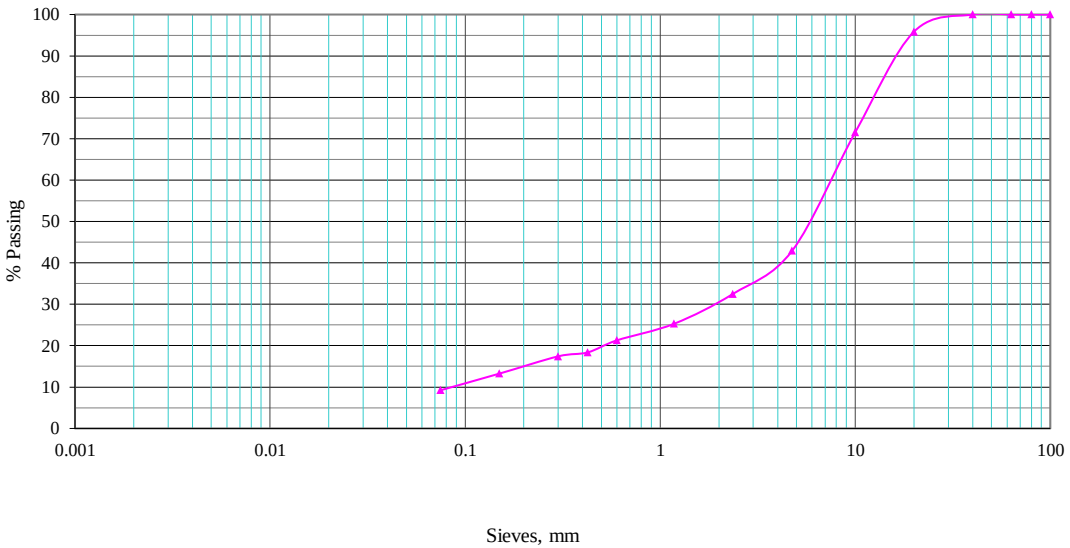
Location : Damauli, Tanahun

Bore Hole : 1

Sample : SPT

Depth (m): 4.5

Total Wt. (gm)	398.45
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	9.24 %	33.71 %	57.06 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0893	1.95	6.05	7.88
C _U	88.24	C _C	5.4

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

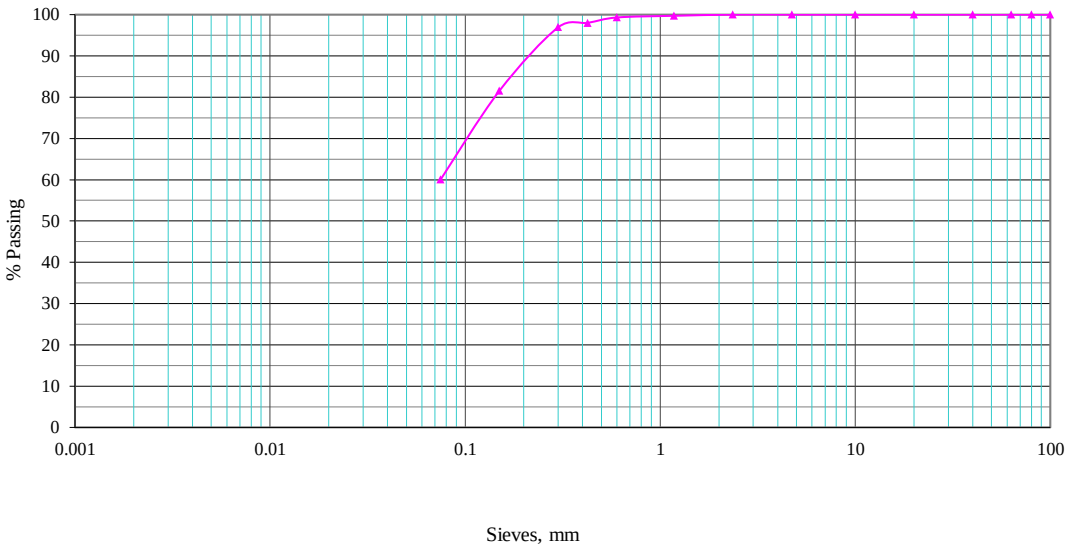
Location : Damauli, Tanahun

Bore Hole : 1

Sample : Disturbed

Depth (m): 4.5

Total Wt. (gm)	232.95
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	60.10 %	39.90 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0125	0.04	0.06	0.07
C _U	5.6	C _C	1.83

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

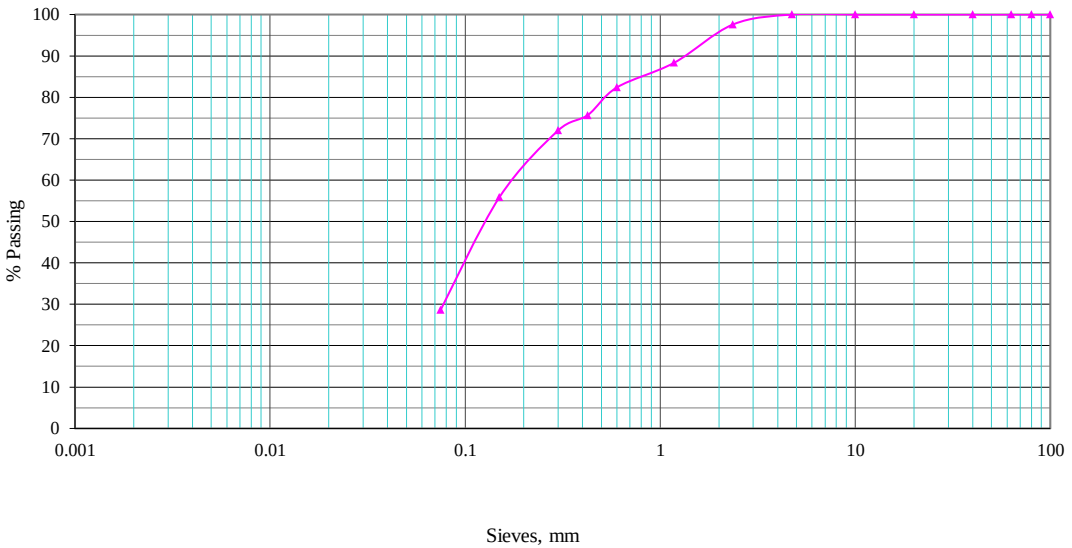
Location : Damauli, Tanahun

Bore Hole : 1

Sample : Disturbed

Depth (m): 7.5

Total Wt. (gm)	522.75
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	28.69 %	71.31 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0261	0.08	0.13	0.19
C _U	7.28	C _C	1.29

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

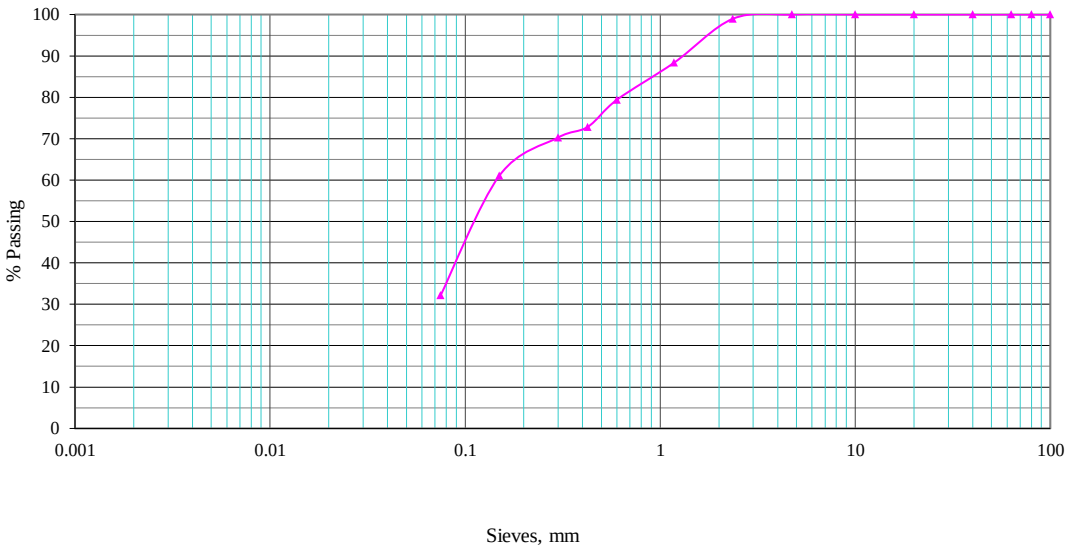
Location : Damauli, Tanahun

Bore Hole : 1

Sample : Disturbed

Depth (m): 9.0

Total Wt. (gm)	636.60
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	32.20 %	67.80 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0233	0.07	0.12	0.15
C _U	6.44	C _C	1.4

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

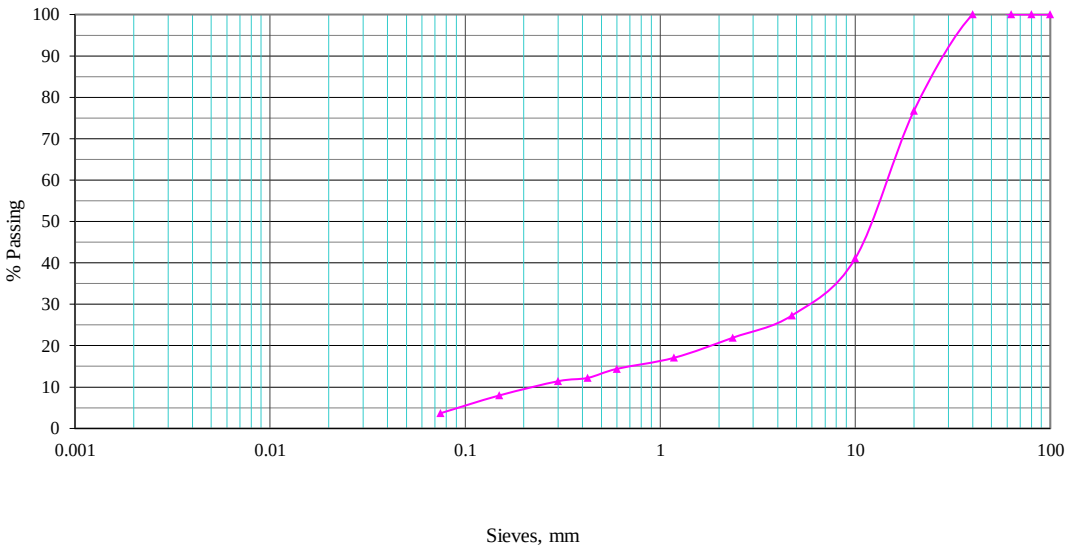
Location : Damauli, Tanahun

Bore Hole : 1

Sample : SPT

Depth (m): 9.0

Total Wt. (gm)	233.05
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	3.69 %	23.64 %	72.67 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.2382	5.77	12.5	15.3
C _U	64.23	C _C	9.14

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

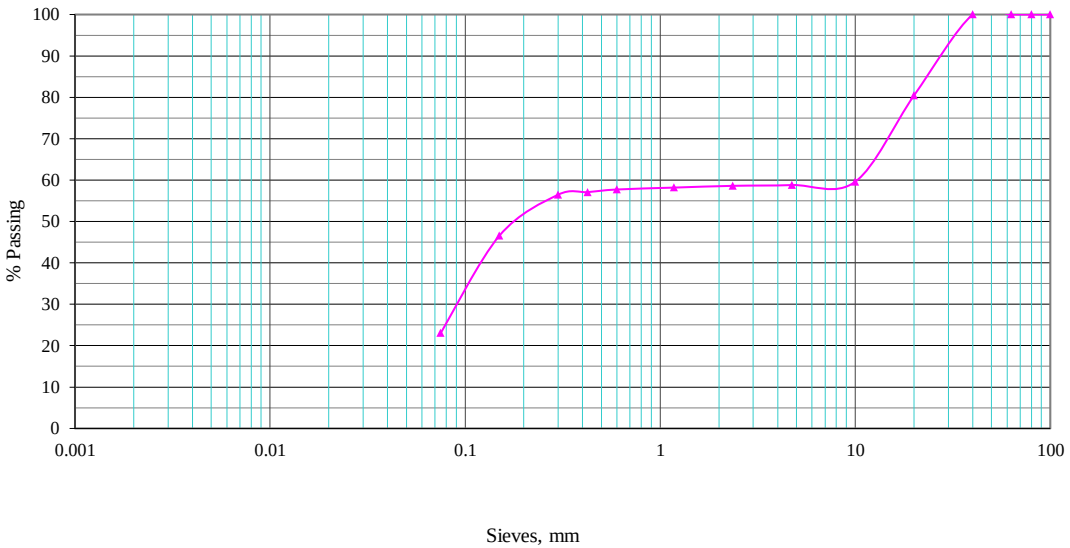
Location : Damauli, Tanahun

Bore Hole : 1

Sample : Disturbed

Depth (m): 10.5

Total Wt. (gm)	435.03
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	23.04 %	35.76 %	41.20 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0326	0.1	0.2	10.19
C _U	312.58	C _C	0.03

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

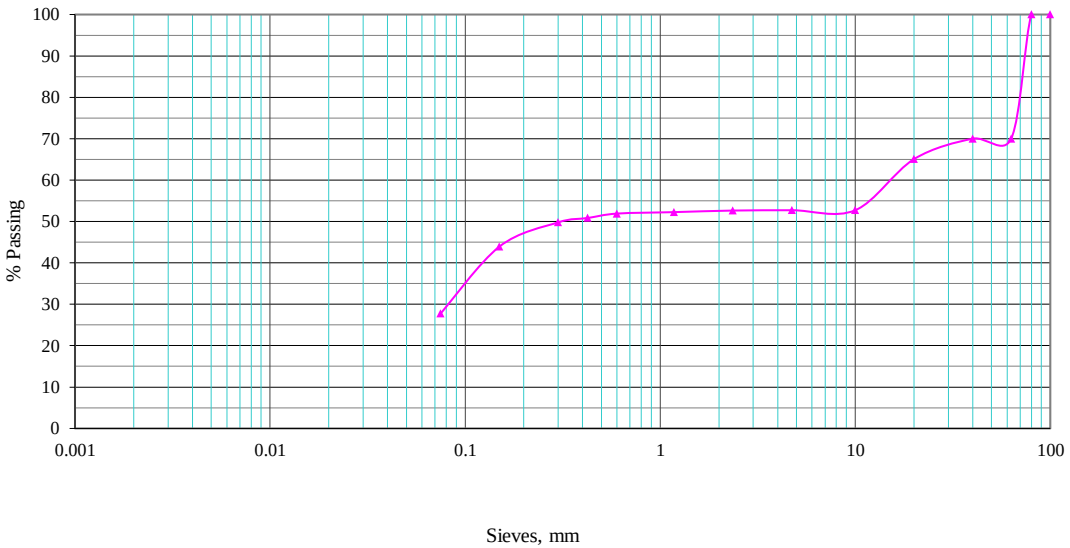
Location : Damauli, Tanahun

Bore Hole : 1

Sample : Disturbed

Depth (m): 12.0

Total Wt. (gm)	680.10
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	27.78 %	24.94 %	47.29 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.027	0.09	0.33	15.9
C _U	588.89	C _C	0.02

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

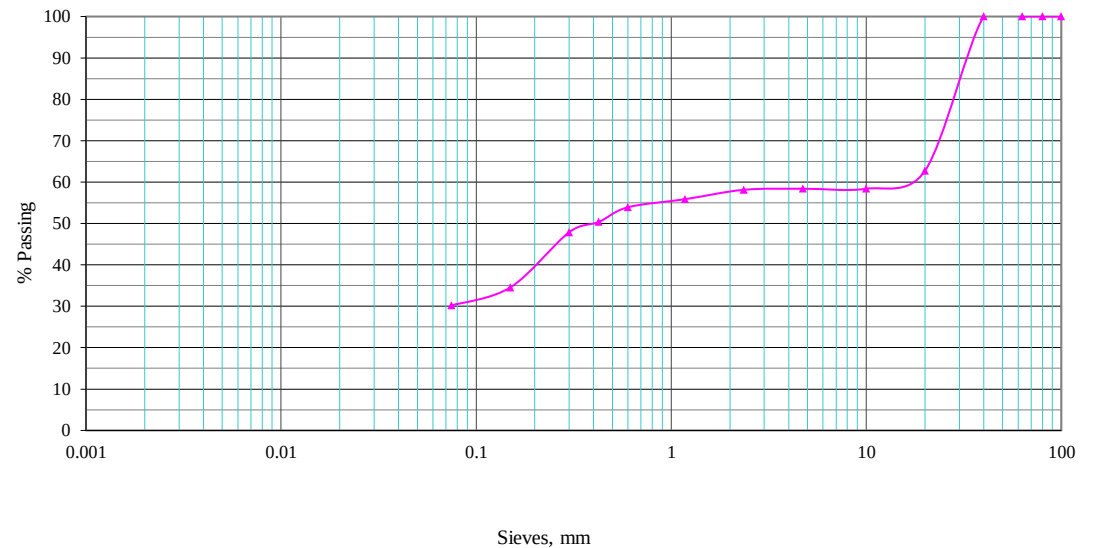
Location : Damauli, Tanahun

Bore Hole : 1

Sample : Disturbed

Depth (m): 13.5

Total Wt. (gm)	330.95
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	30.22 %	28.18 %	41.61 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0248	0.07	0.41	13.71
C _U	552.82	C _C	0.01

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

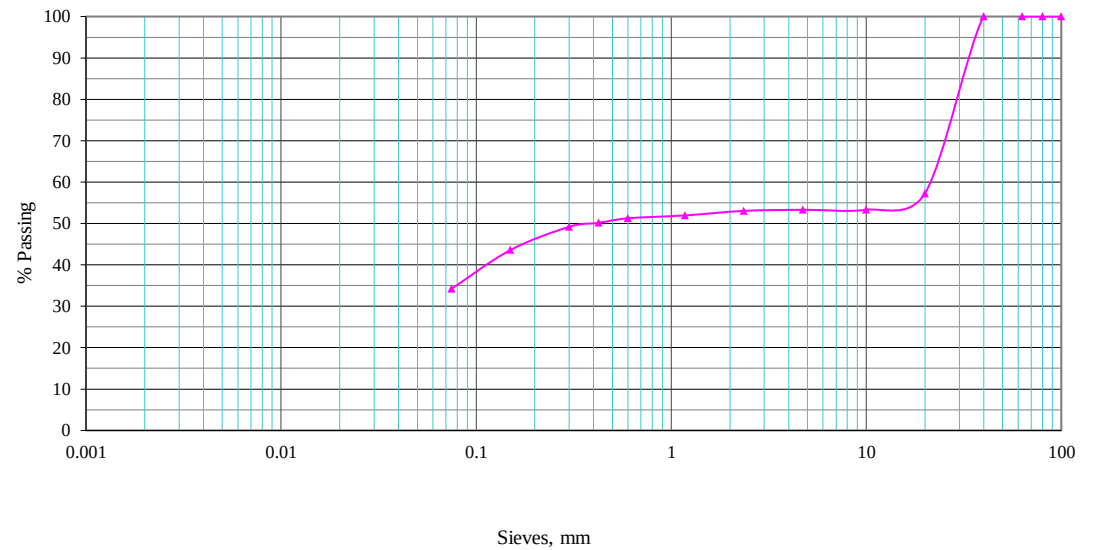
Location : Damauli, Tanahun

Bore Hole : 1

Sample : Disturbed

Depth (m): 15.0

Total Wt. (gm)	401.45
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	34.23 %	19.08 %	46.69 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0219	0.07	0.4	25.07
C _U	1144.75	C _C	0.01

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

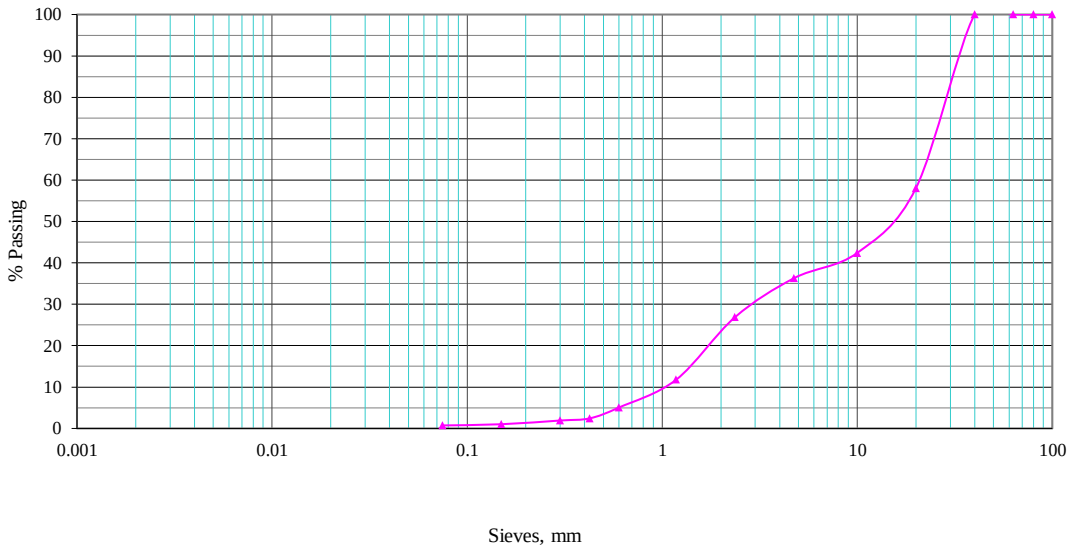
Location : Damauli, Tanahun

Bore Hole : 2

Sample : SPT

Depth (m): 1.5

Total Wt. (gm)	172.35
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	0.73 %	35.60 %	63.68 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
1.0268	3.15	14.84	23.67
C _U	23.05	C _C	0.41

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

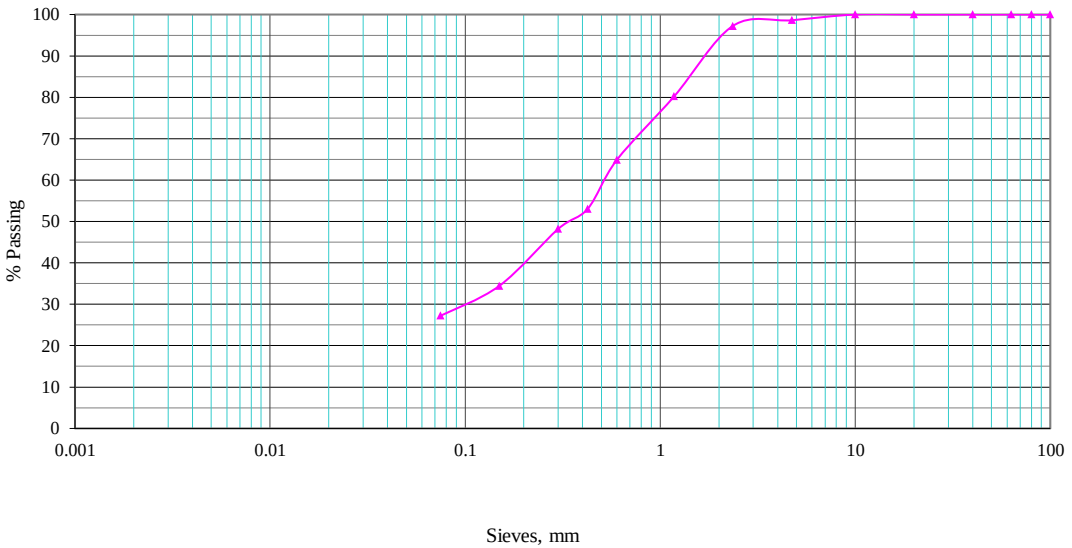
Location : Damauli, Tanahun

Bore Hole : 2

Sample : Disturbed

Depth (m): 1.5

Total Wt. (gm)	218.35
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	27.25 %	71.38 %	1.37 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0275	0.1	0.35	0.53
C _U	19.27	C _C	0.69

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

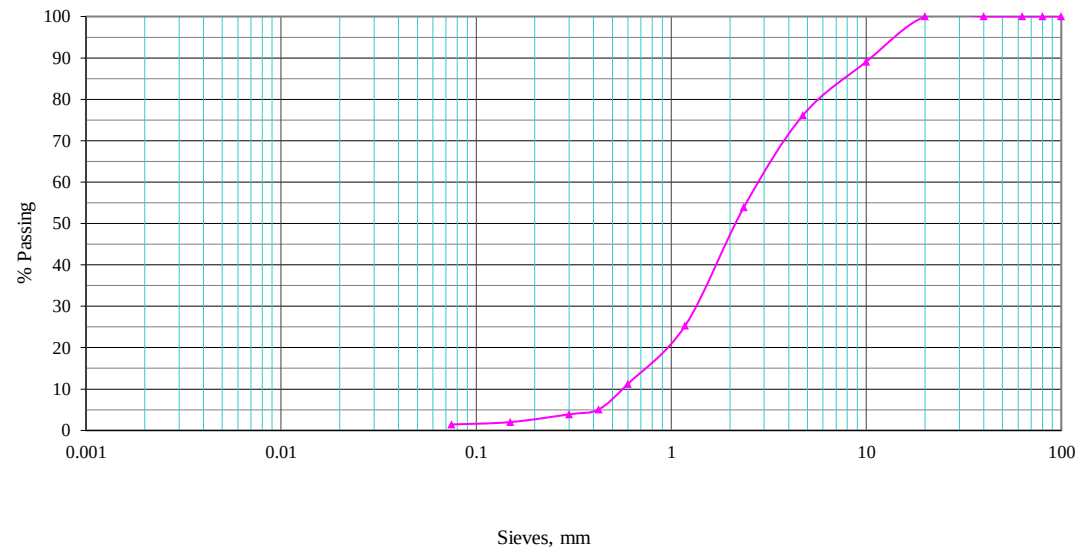
Client : Nepal Electricity Authority

Location : Damauli, Tanahun

Bore Hole : 2

Depth (m): 3.0

Total Wt. (gm)	151.25
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	1.45 %	74.74 %	23.80 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.5647	1.37	2.2	3.01
C _U	5.33	C _C	1.1

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

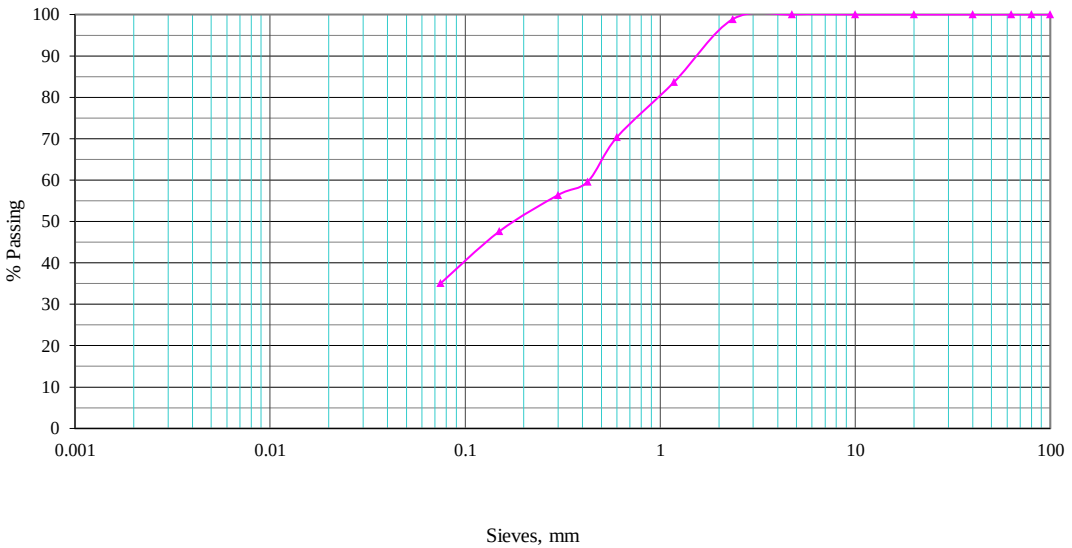
Location : Damauli, Tanahun

Bore Hole : 2

Sample : Disturbed

Depth (m): 3.0

Total Wt. (gm)	326.45
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	35.07 %	64.93 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0214	0.06	0.19	0.43
C _U	20.09	C _C	0.39

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

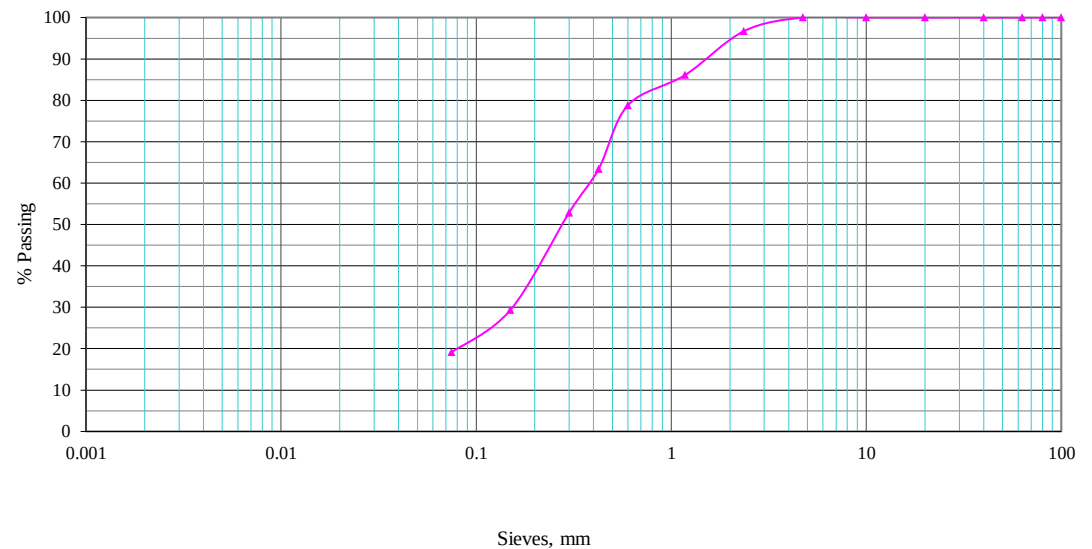
Location : Damauli, Tanahun

Bore Hole : 2

Sample : SPT

Depth (m): 4.5

Total Wt. (gm)	462.85
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	19.19 %	80.81 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0391	0.15	0.28	0.38
C _U	9.72	C _C	1.51

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

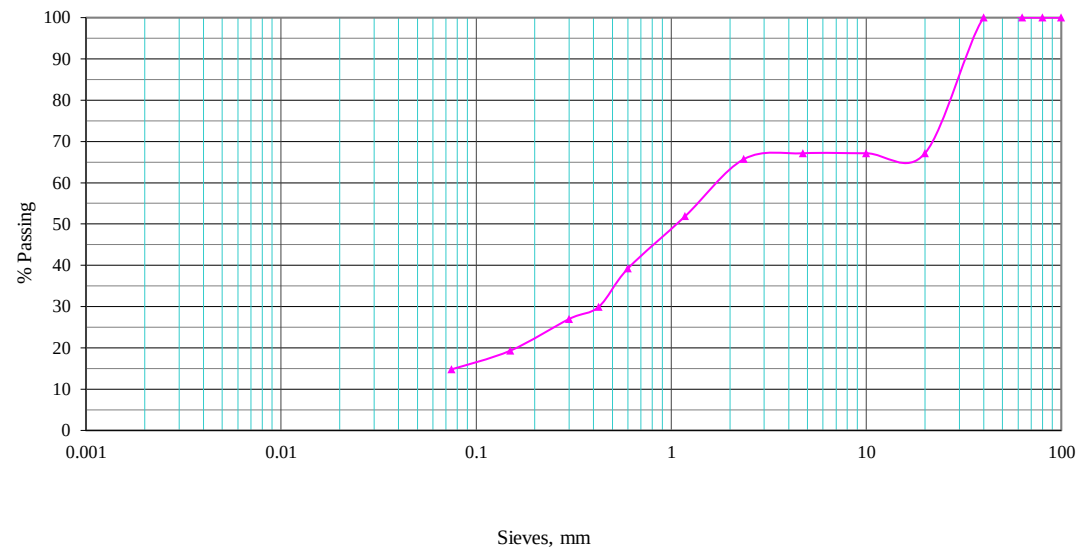
Location : Damauli, Tanahun

Bore Hole : 2

Sample : Disturbed

Depth (m): 4.5

Total Wt. (gm)	289.40
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	14.81 %	52.33 %	32.86 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0507	0.43	1.09	1.87
C _U	36.88	C _C	1.95

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

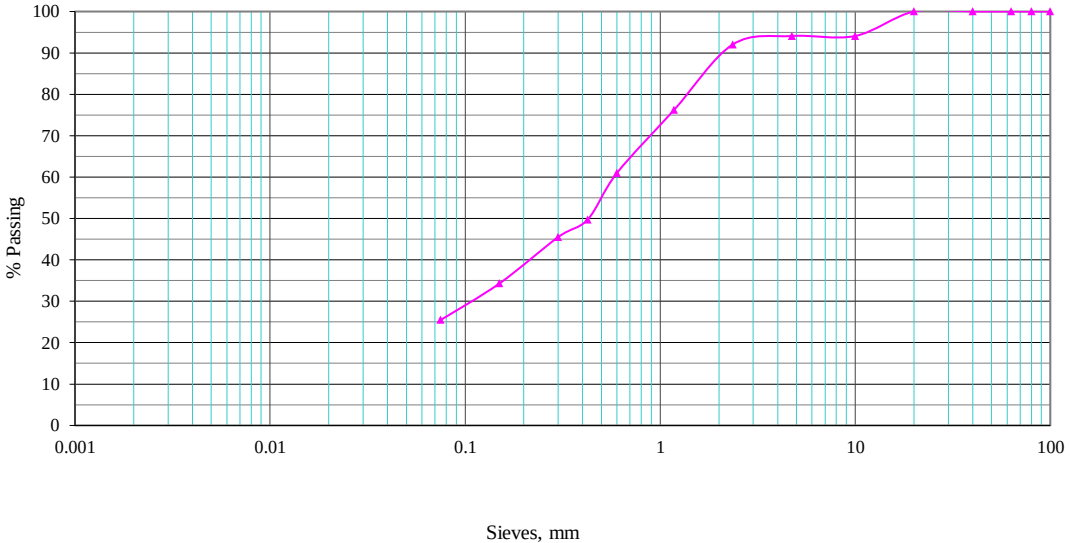
Location : Damauli, Tanahun

Bore Hole : 2

Sample : Disturbed

Depth (m): 6.0

Total Wt. (gm)	514.40
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	25.49 %	68.60 %	5.91 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0294	0.11	0.43	0.58
C _U	19.73	C _C	0.71

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

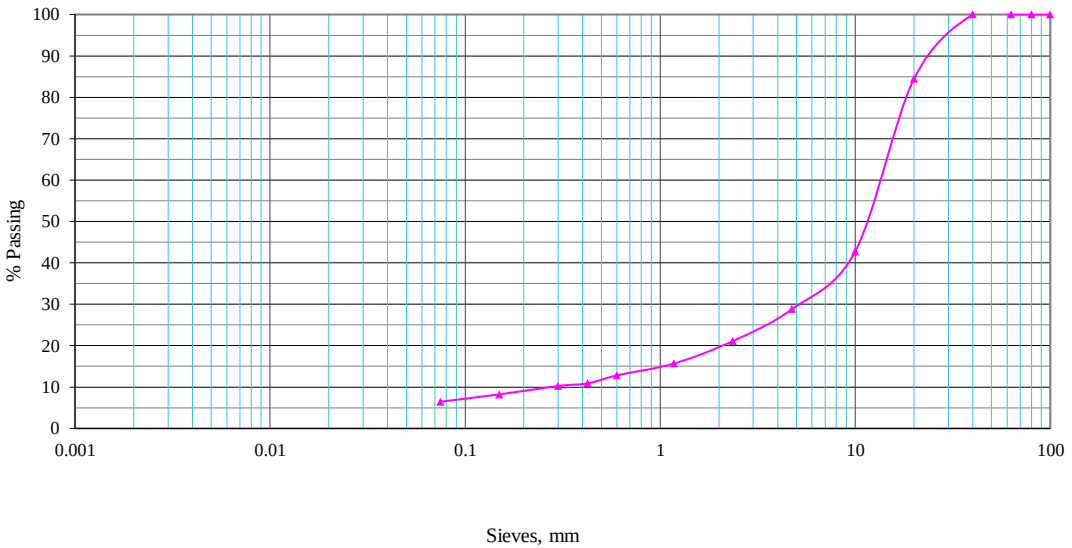
Location : Damauli, Tanahun

Bore Hole : 2

Sample : SPT

Depth (m): 6.0

Total Wt. (gm)	476.15
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	6.47 %	22.36 %	71.18 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.2808	5.19	11.74	14.14
C _U	50.36	C _C	6.78

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

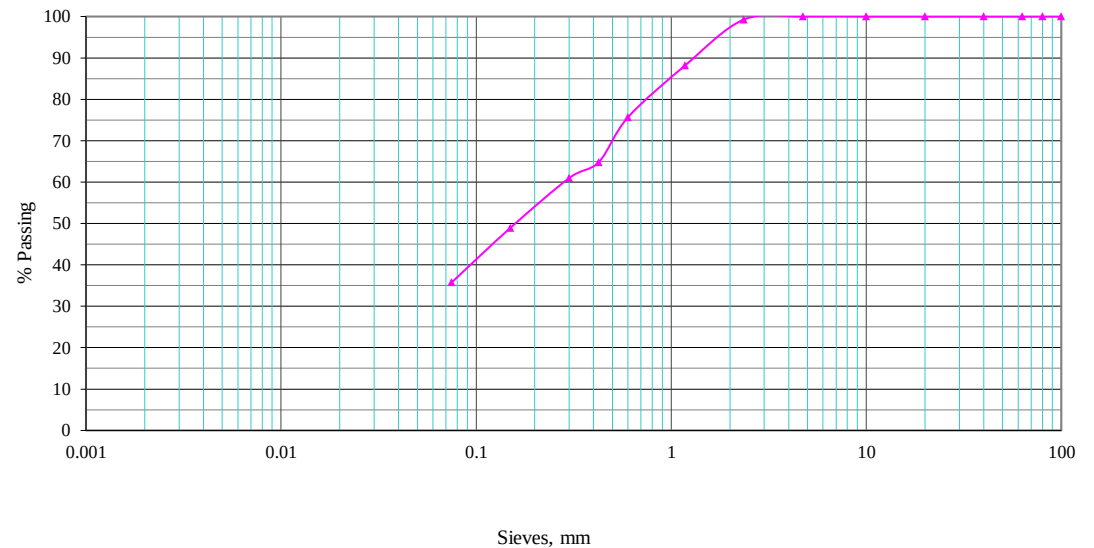
Location : Damauli, Tanahun

Bore Hole : 2

Sample : Disturbed

Depth (m): 7.5

Total Wt. (gm)	276.75
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	35.77 %	64.23 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.021	0.06	0.16	0.29
C _U	13.81	C _C	0.59

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

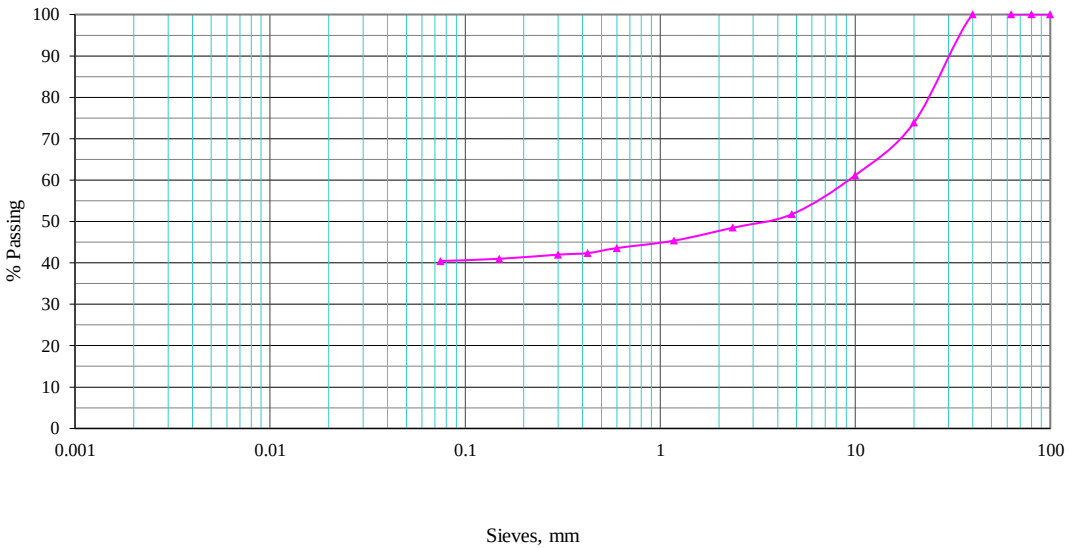
Location : Damauli, Tanahun

Bore Hole : 2

Sample : SPT

Depth (m): 7.5

Total Wt. (gm)	320.00
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	40.45 %	11.33 %	48.22 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0185	0.06	3.45	9.35
C _U	505.41	C _C	0.02

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

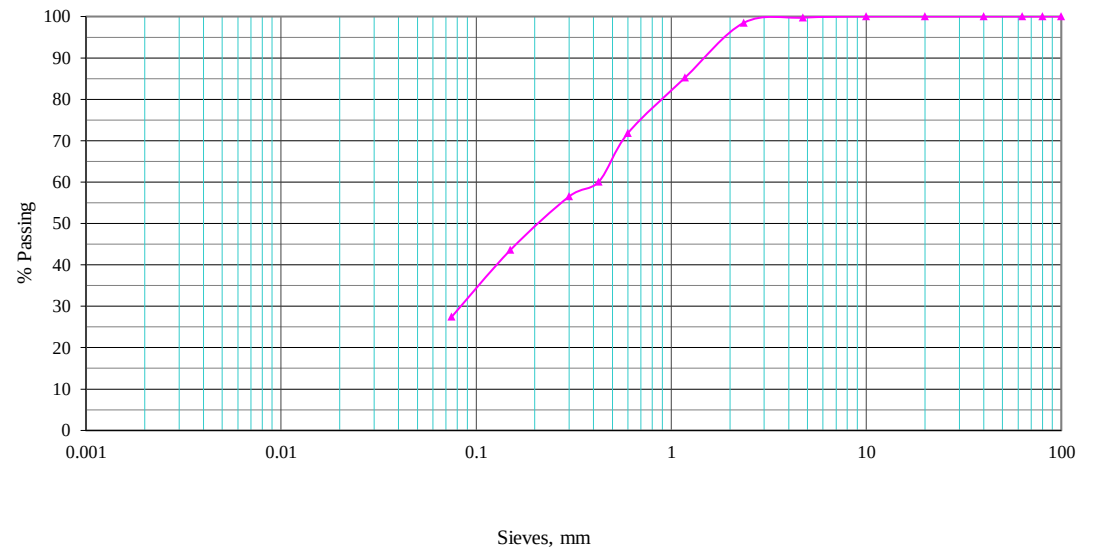
Client : Nepal Electricity Authority

Location : Damauli, Tanahun

Bore Hole : 2

Depth (m): 9.0

Total Wt. (gm)	185.75
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	27.46 %	72.27 %	0.27 %

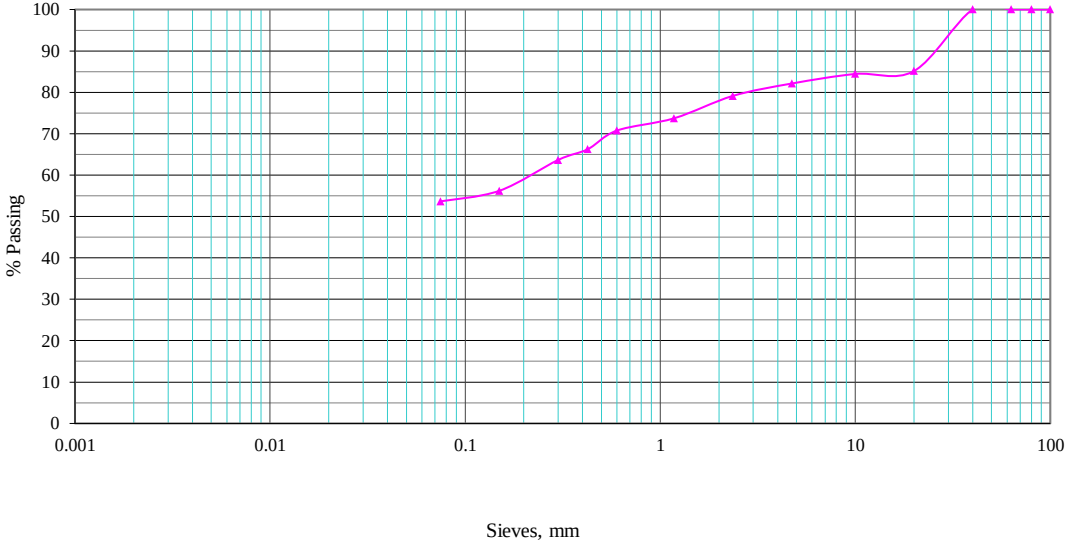
D_{10}	D_{30}	D_{50}	D_{60}
0.0273	0.09	0.22	0.42
C_U	15.38	C_C	0.71

GRAIN SIZE ANALYSIS

Client : Nepal Electricity Authority

Bore Hole : 2

Depth (m): 9.0

[illegible]

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.014	0.04	0.07	0.23
C _U	16.43	C _C	0.5

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

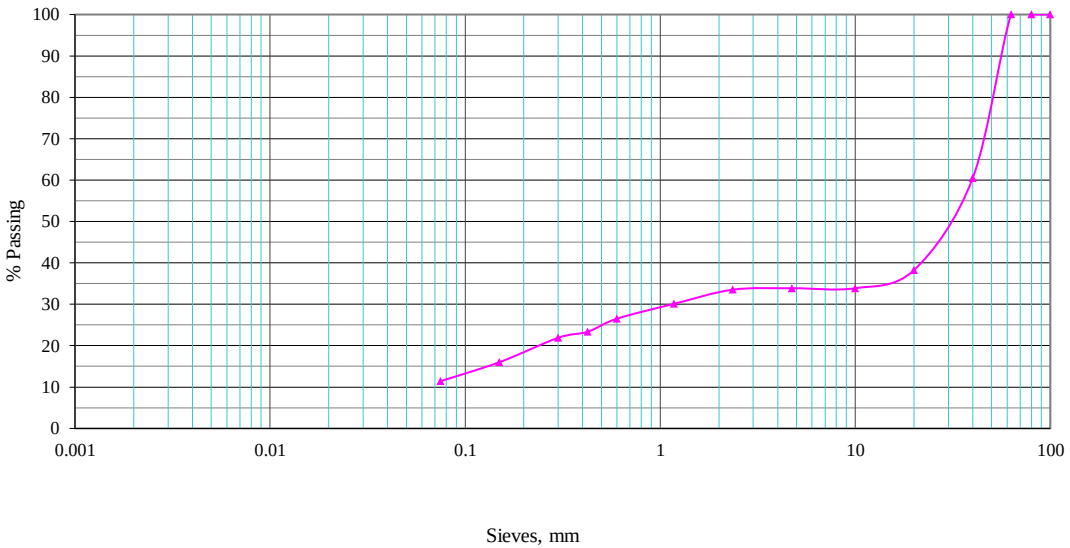
Location : Damauli, Tanahun

Bore Hole : 2

Sample : Disturbed

Depth (m): 10.5

Total Wt. (gm)	645.25
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	11.44 %	22.43 %	66.13 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0656	1.16	30.57	39.57
C _U	603.2	C _C	0.52

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

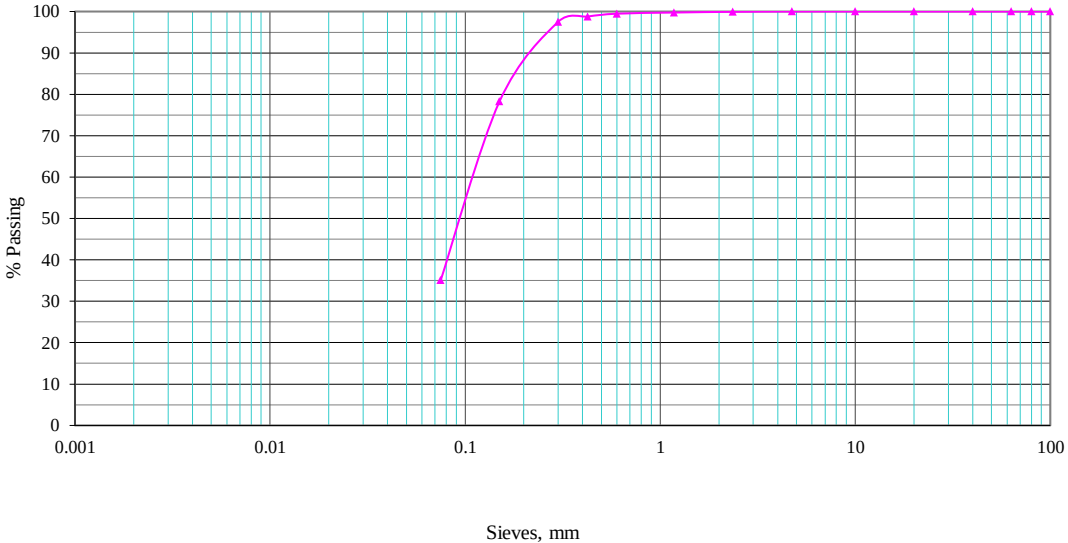
Location : Damauli, Tanahun

Bore Hole : 3

Sample : Disturbed

Depth (m): 1.5

Total Wt. (gm)	284.95
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	35.09 %	64.91 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0214	0.06	0.1	0.12
C _U	5.61	C _C	1.4

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

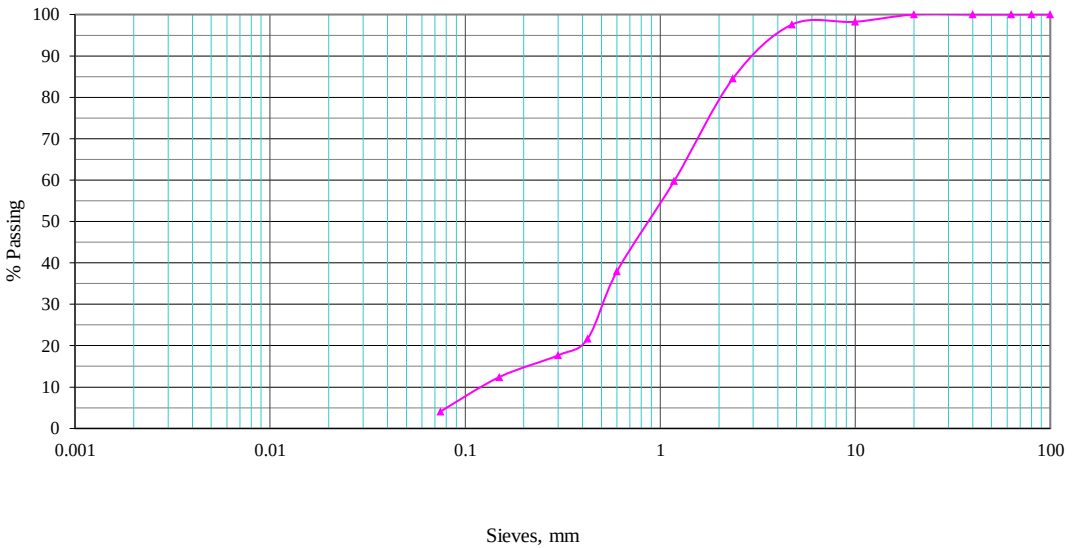
Location : Damauli, Tanahun

Bore Hole : 3

Sample : SPT

Depth (m): 3.0

Total Wt. (gm)	727.00
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	4.13 %	93.47 %	2.41 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.1281	0.51	0.92	1.19
C _U	9.29	C _C	1.71

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

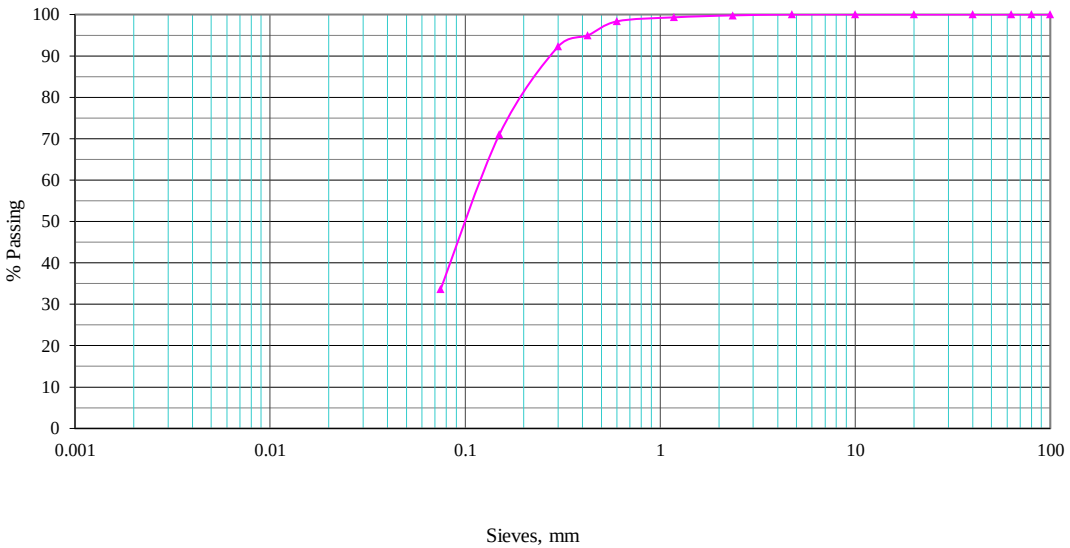
Location : Damauli, Tanahun

Bore Hole : 3

Sample : Disturbed

Depth (m): 3.0

Total Wt. (gm)	552.65
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	33.66 %	66.34 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0223	0.07	0.11	0.13
C _U	5.83	C _C	1.69

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

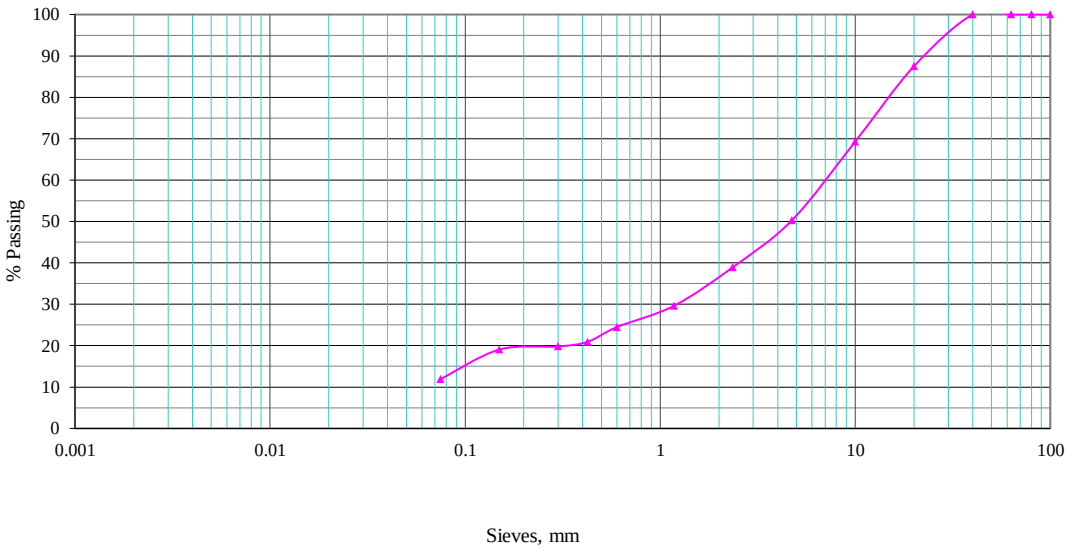
Location : Damauli, Tanahun

Bore Hole : 3

Sample : SPT

Depth (m): 4.5

Total Wt. (gm)	604.65
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	11.91 %	38.44 %	49.66 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.063	1.22	4.68	7.42
C _U	117.78	C _C	3.18

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

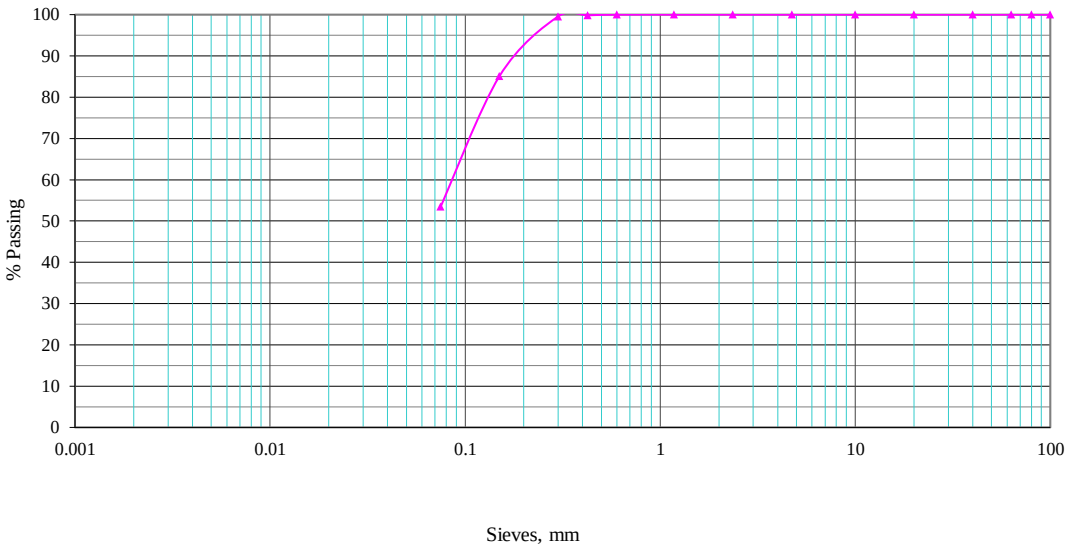
Location : Damauli, Tanahun

Bore Hole : 3

Sample : Disturbed

Depth (m): 4.5

Total Wt. (gm)	369.65
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	53.50 %	46.50 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.014	0.04	0.07	0.09
C _U	6.43	C _C	1.27

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

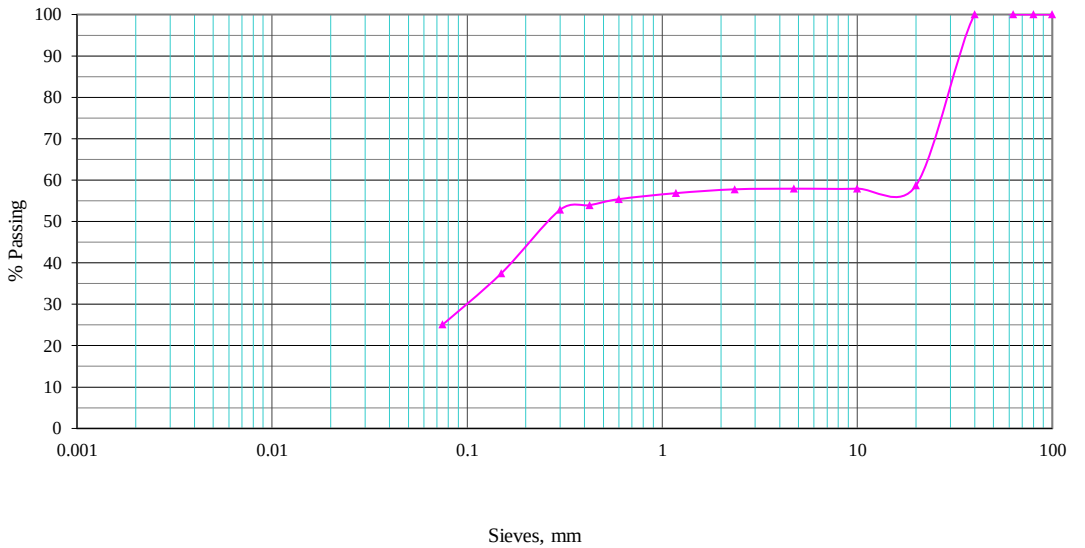
Location : Damauli, Tanahun

Bore Hole : 3

Sample : Disturbed

Depth (m): 6.0

Total Wt. (gm)	686.55
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	25.10 %	32.82 %	42.08 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0299	0.1	0.27	22.53
C _U	753.51	C _C	0.01

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

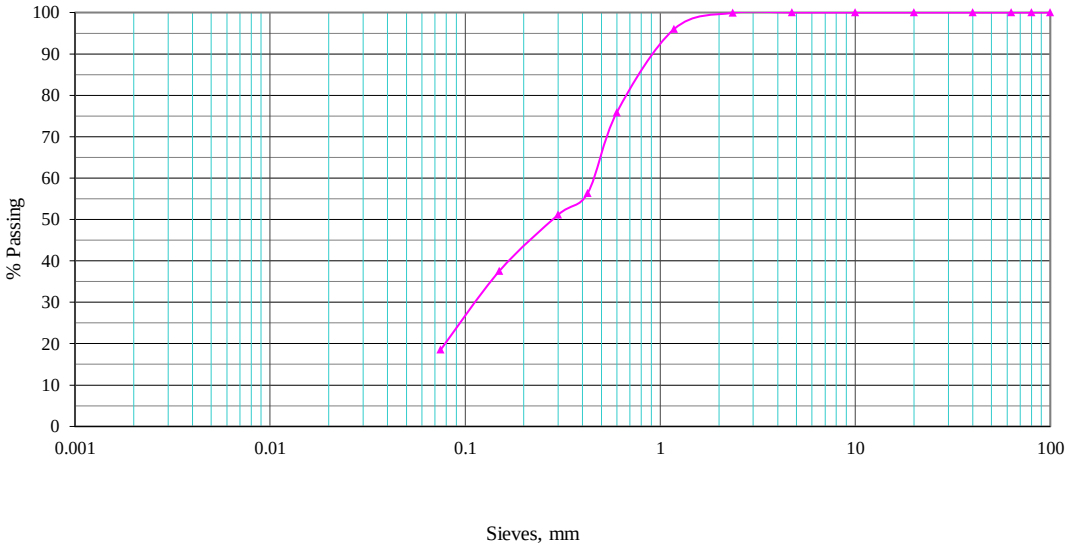
Location : Damauli, Tanahun

Bore Hole : 3

Sample : Disturbed

Depth (m): 7.5

Total Wt. (gm)	614.75
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	18.54 %	81.46 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0404	0.12	0.29	0.46
C _U	11.39	C _C	0.77

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

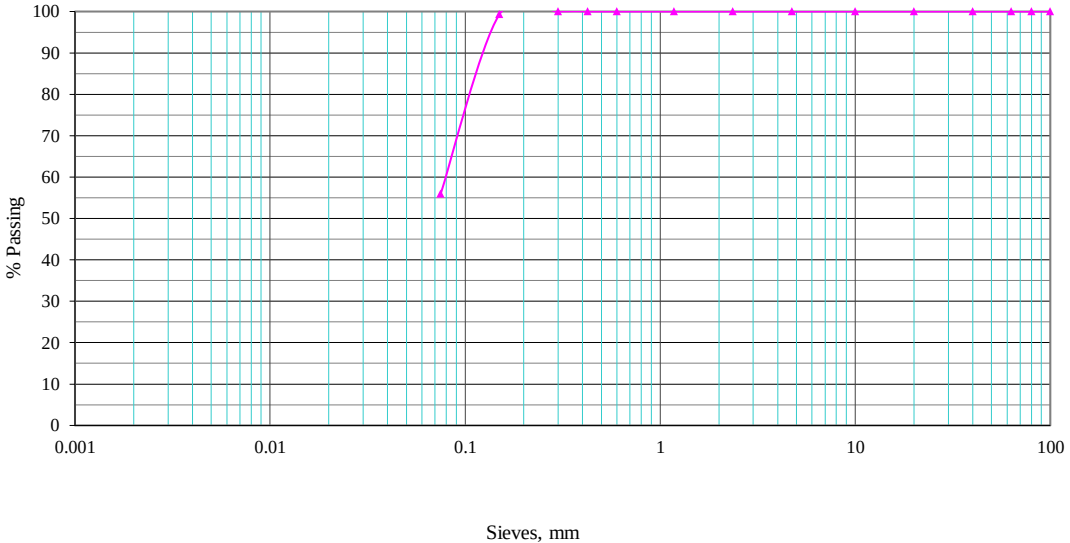
Location : Damauli, Tanahun

Bore Hole : 3

Sample : SPT

Depth (m): 7.5

Total Wt. (gm)	415.25
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	55.98 %	44.02 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0134	0.04	0.07	0.08
C _U	5.97	C _C	1.49

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

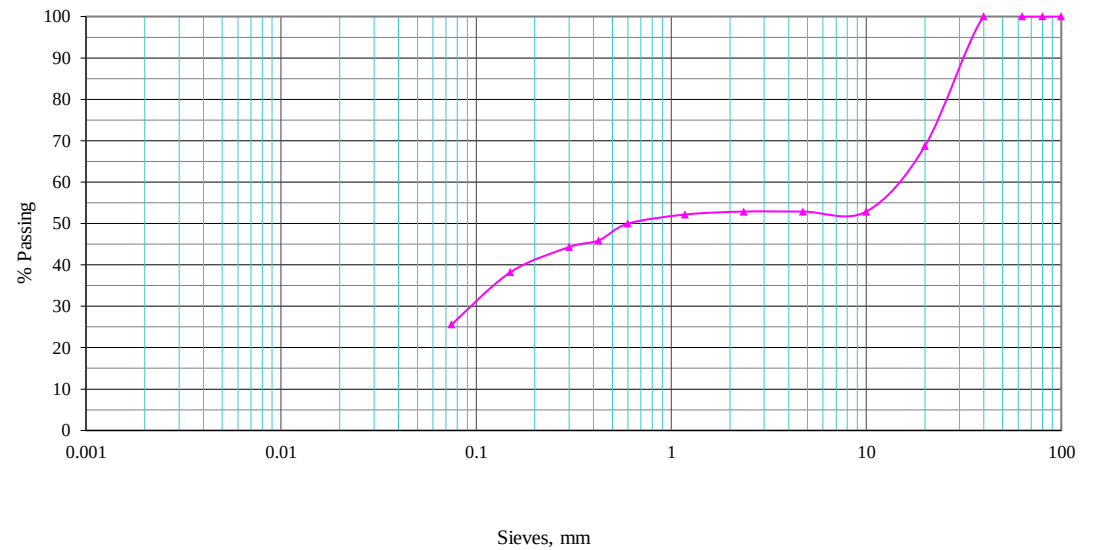
Client : Nepal Electricity Authority

Location : Damauli, Tanahun

Bore Hole : 3

Depth (m): 9.0

Total Wt. (gm)	722.70
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	25.62 %	27.26 %	47.12 %

D_{10}	D_{30}	D_{50}	D_{60}
0.0293	0.1	0.61	14.49
C_U	494.54	C_C	0.02

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

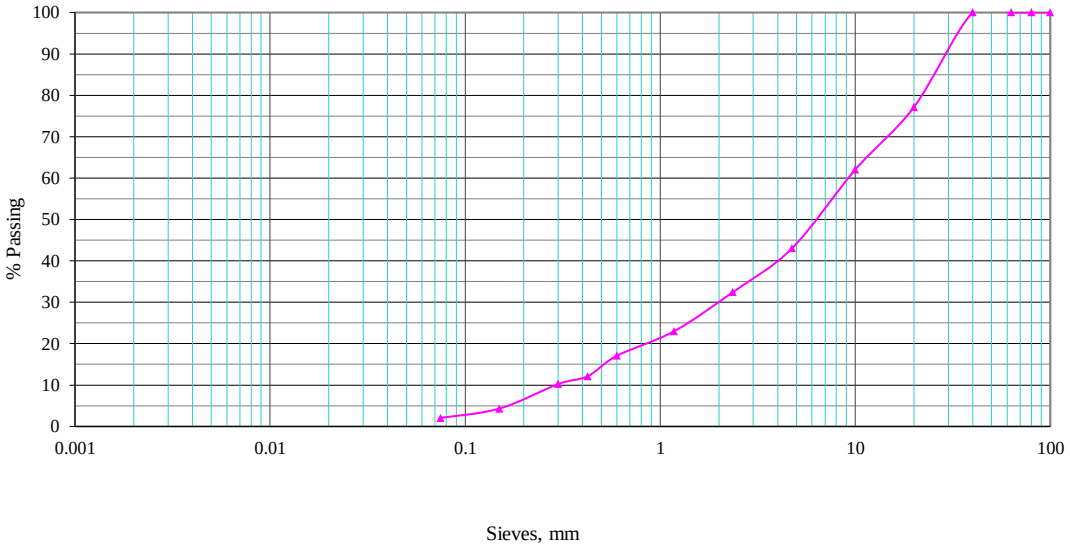
Location : Damauli, Tanahun

Bore Hole : 3

Sample : SPT

Depth (m): 9.0

Total Wt. (gm)	579.90
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	2.07 %	41.00 %	56.93 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.2939	2.05	6.67	9.44
C _U	32.12	C _C	1.51

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

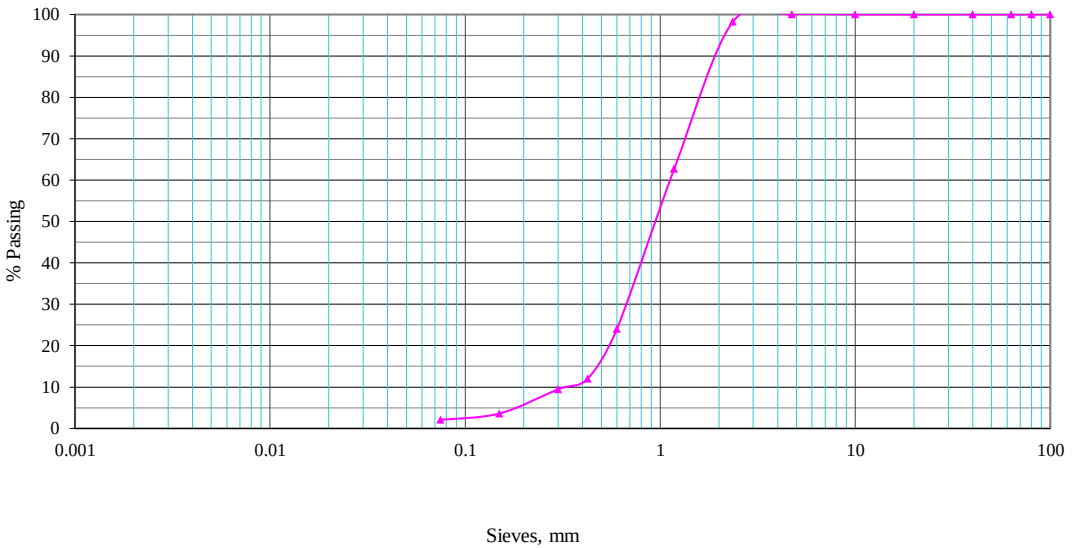
Location : Damauli, Tanahun

Bore Hole : 3

Sample : Disturbed

Depth (m): 10.0

Total Wt. (gm)	290.15
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	2.10 %	97.90 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.3261	0.69	0.99	1.14
C _U	3.5	C _C	1.28

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

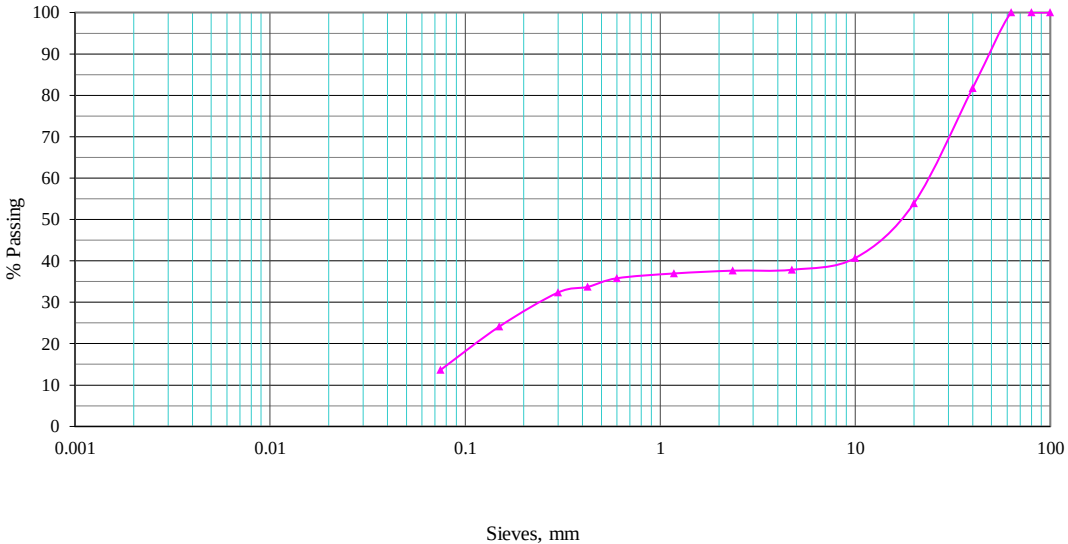
Location : Damauli, Tanahun

Bore Hole : 3

Sample : Disturbed

Depth (m): 10.5

Total Wt. (gm)	622.90
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	13.68 %	24.18 %	62.14 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0548	0.26	17.04	24.37
C _U	444.71	C _C	0.05

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

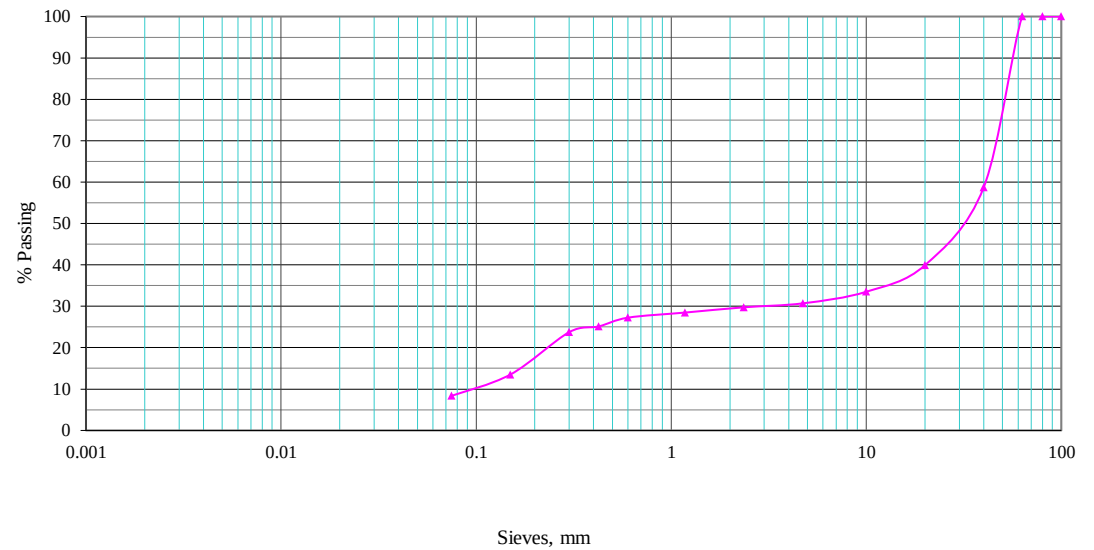
Location : Damauli, Tanahun

Bore Hole : 4

Sample : Disturebed

Depth (m): 1.5

Total Wt. (gm)	496.50
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	8.38 %	22.34 %	69.28 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0987	2.98	30.72	41.87
C _U	424.21	C _C	2.15

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

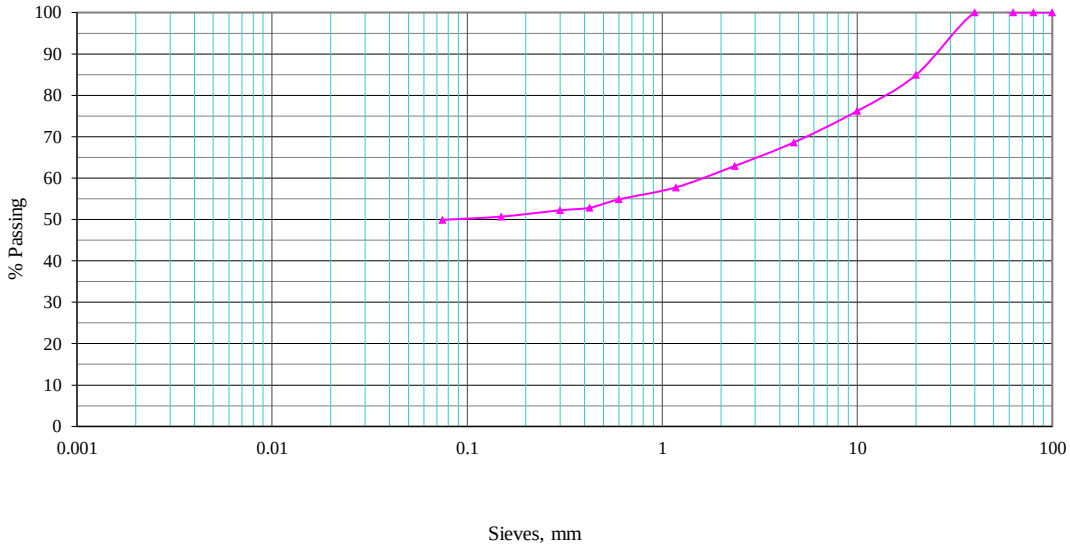
Location : Damauli, Tanahun

Bore Hole : 4

Sample : SPT

Depth (m): 3.0

Total Wt. (gm)	360.00
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	49.92 %	18.74 %	31.35 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.015	0.05	0.08	1.69
C _U	112.67	C _C	0.1

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

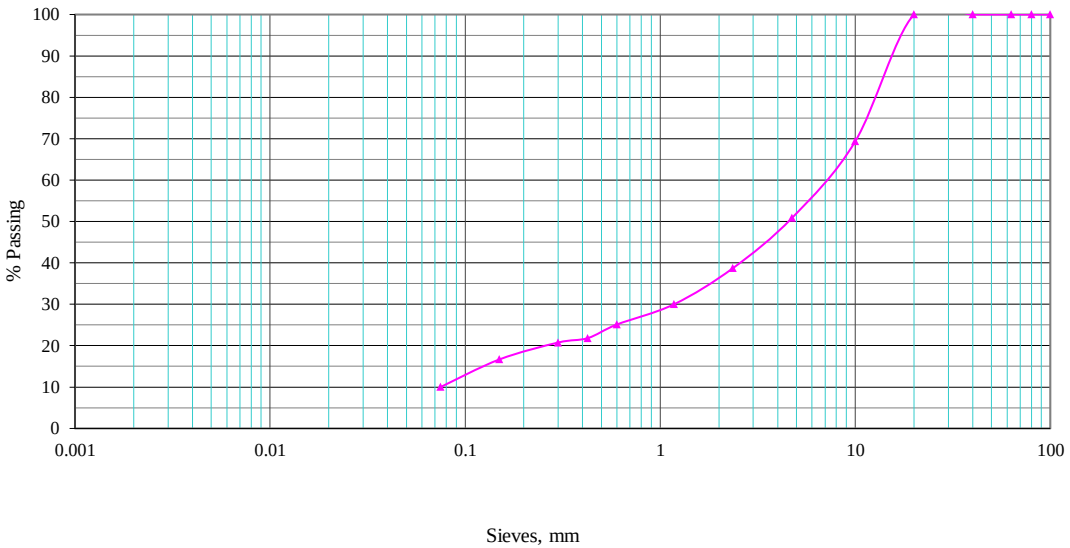
Location : Damauli, Tanahun

Bore Hole : 4

Sample : Disturbed

Depth (m): 3.0

Total Wt. (gm)	375.36
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	10.02 %	40.88 %	49.10 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0749	1.18	4.57	7.34
C _U	98	C _C	2.53

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

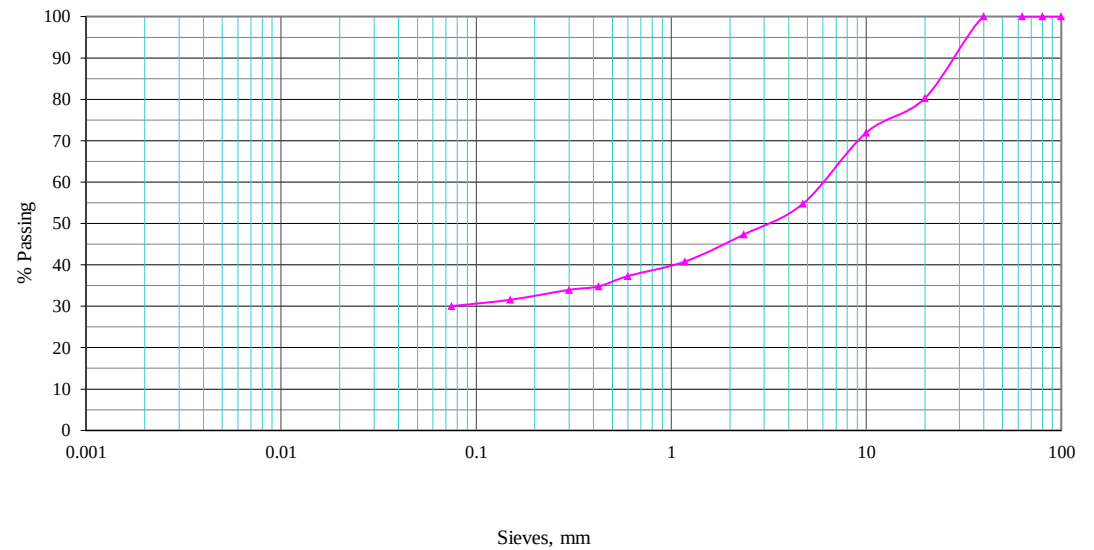
Location : Damauli, Tanahun

Bore Hole : 4

Sample : SPT

Depth (m): 4.5

Total Wt. (gm)	480.00
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	30.04 %	24.77 %	45.19 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.025	0.07	3.21	6.34
C _U	253.6	C _C	0.03

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

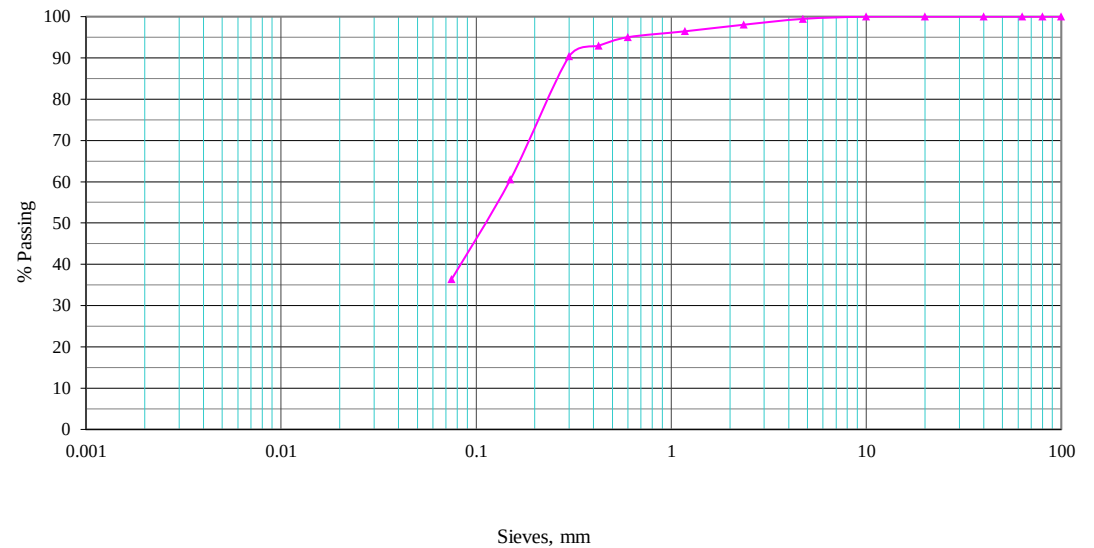
Client : Nepal Electricity Authority

Location : Damauli, Tanahun

Bore Hole : 4

Depth (m): 4.5

Total Wt. (gm)	250.75
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	36.43 %	63.03 %	0.54 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0206	0.06	0.12	0.15
C _U	7.28	C _C	1.17

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

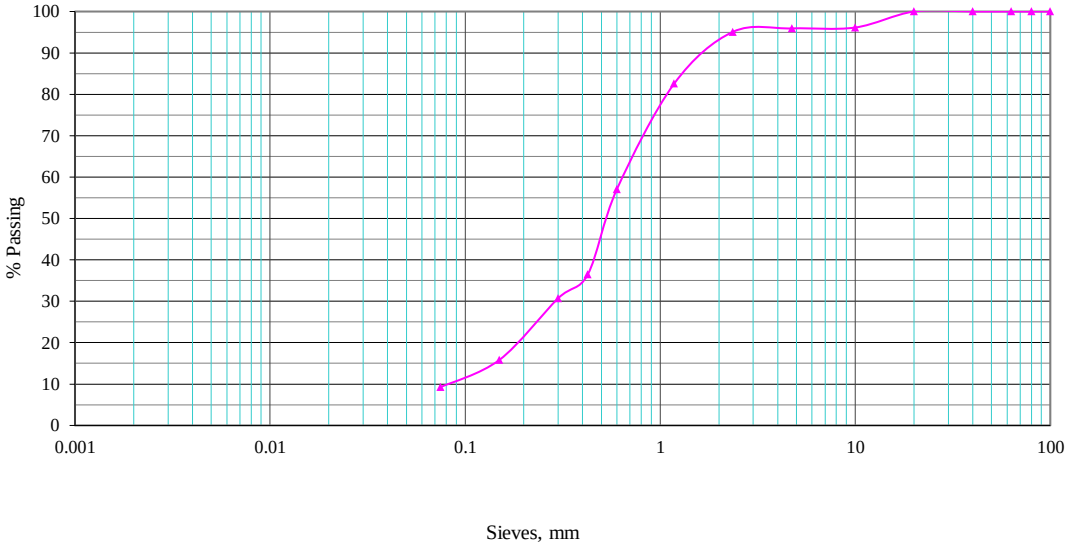
Location : Damauli, Tanahun

Bore Hole : 4

Sample : Disturbed

Depth (m): 6.0

Total Wt. (gm)	335.85
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	9.29 %	86.63 %	4.08 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0831	0.29	0.54	0.67
C _U	8.06	C _C	1.51

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

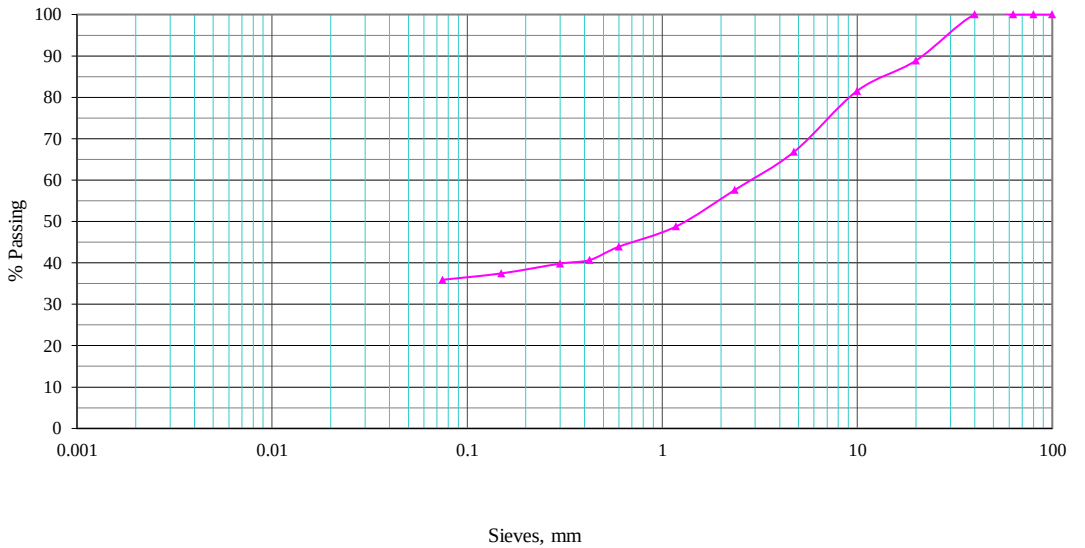
Location : Damauli, Tanahun

Bore Hole : 4

Sample : SPT

Depth (m): 6.0

Total Wt. (gm)	715.00
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	35.92 %	30.93 %	33.15 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0209	0.06	1.34	2.97
C _U	142.11	C _C	0.06

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

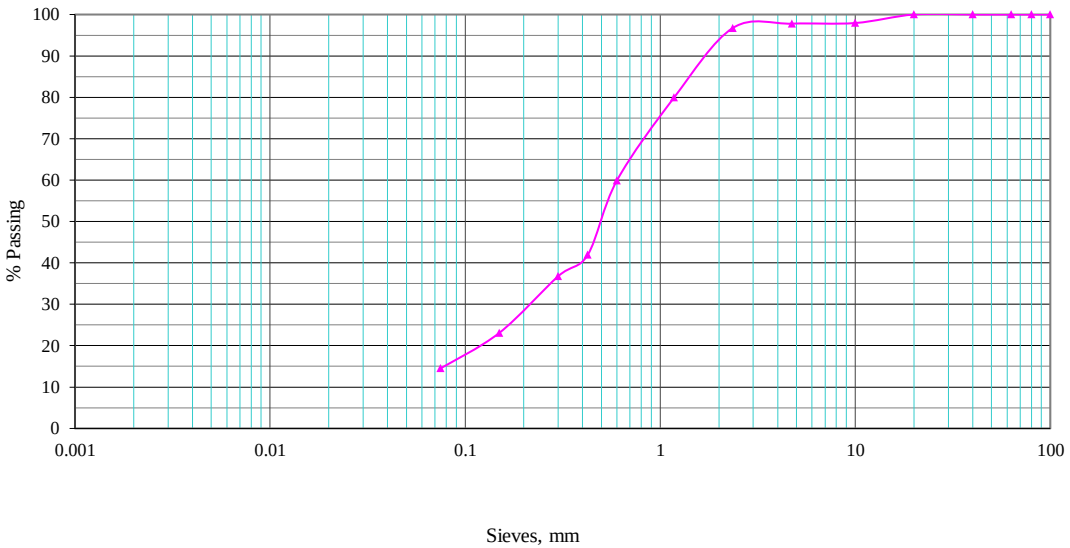
Location : Damauli, Tanahun

Bore Hole : 4

Sample : Disturbed

Depth (m): 7.5

Total Wt. (gm)	378.40
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	14.53 %	83.26 %	2.21 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0516	0.23	0.5	0.6
C _U	11.63	C _C	1.71

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

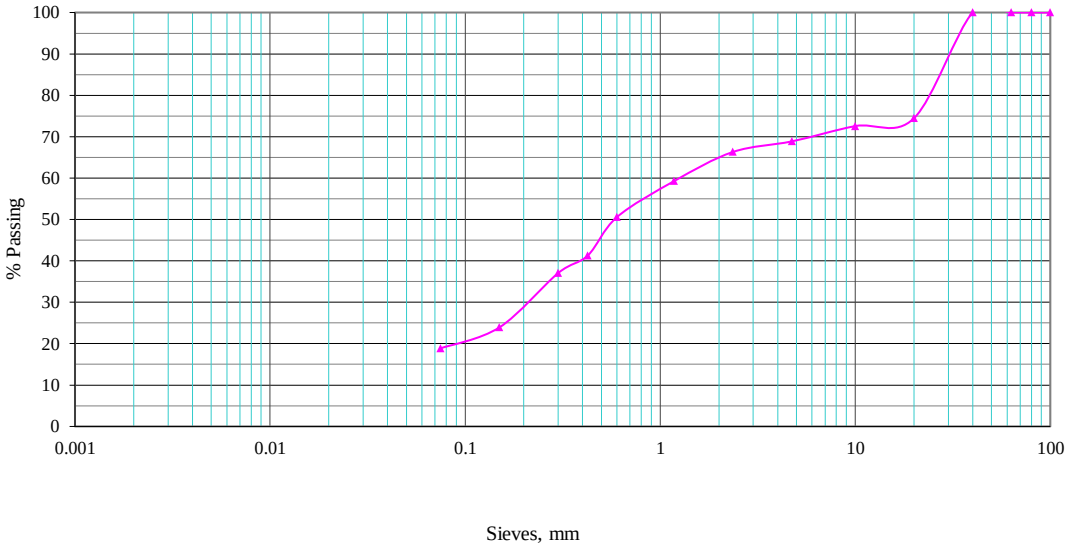
Location : Damauli, Tanahun

Bore Hole : 4

Sample : SPT

Depth (m): 7.5

Total Wt. (gm)	225.45
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	18.90 %	49.99 %	31.12 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0397	0.22	0.59	1.3
C _U	32.75	C _C	0.94

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

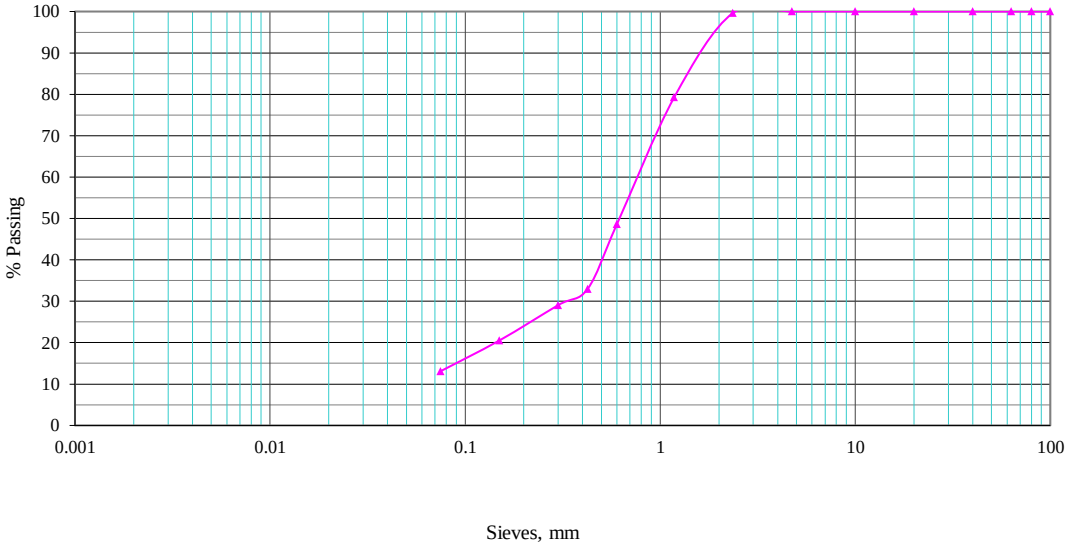
Location : Damauli, Tanahun

Bore Hole : 4

Sample : Disturbed

Depth (m): 9.0

Total Wt. (gm)	448.95
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	13.12 %	86.88 %	0.00 %

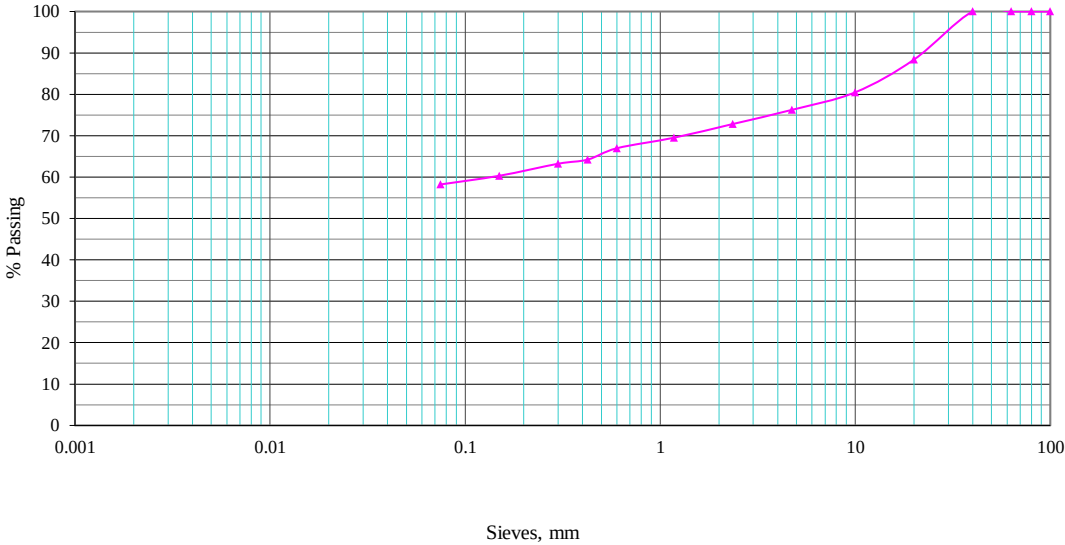
D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0572	0.33	0.63	0.82
C _U	14.34	C _C	2.32

GRAIN SIZE ANALYSIS

Client : Nepal Electricity Authority

Bore Hole : 4

Depth (m): 9.0

[illegible]

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0129	0.04	0.06	0.14
C _U	10.85	C _C	0.89

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

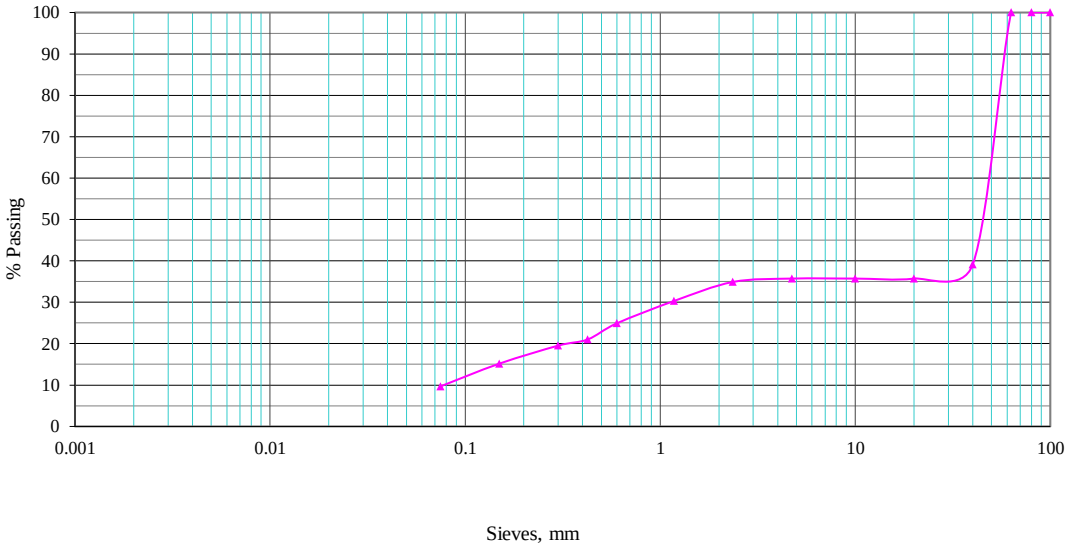
Location : Damauli, Tanahun

Bore Hole : 4

Sample : Disturbed

Depth (m): 10.5

Total Wt. (gm)	837.30
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	9.70 %	26.02 %	64.28 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0791	1.15	50.75	60.6
C _U	766.12	C _C	0.28

GRAIN SIZE ANALYSIS

Project : Geotechnical Investigation of Proposed Substation Site

Client : Nepal Electricity Authority

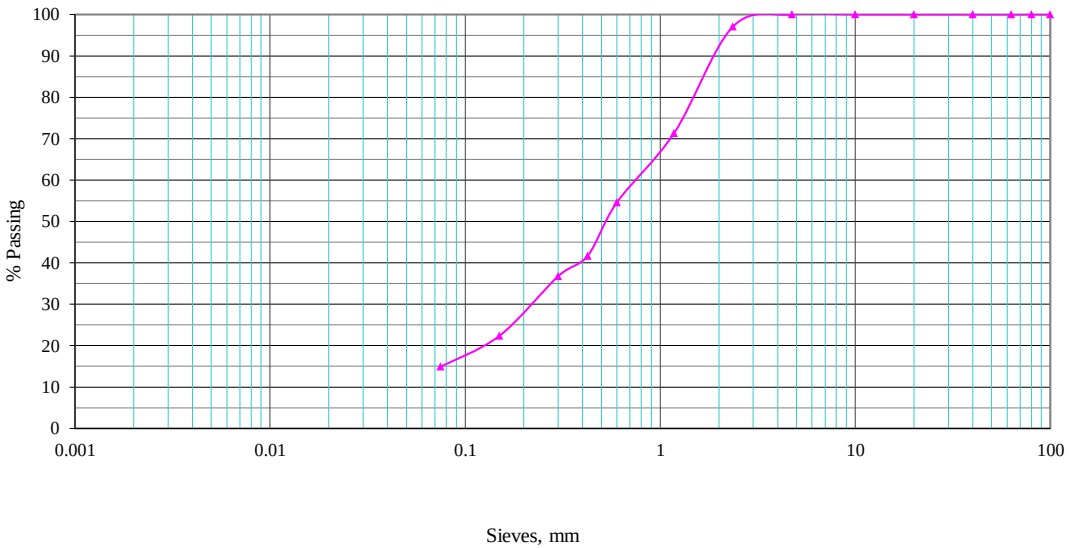
Location : Damauli, Tanahun

Bore Hole : 4

Sample : Disturbed

Depth (m): 12.0

Total Wt. (gm)	404.15
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[illegible]

CLAY	SILT	SAND	GRAVEL
0.00 %	14.94 %	85.06 %	0.00 %

D ₁₀	D ₃₀	D ₅₀	D ₆₀
0.0502	0.23	0.54	0.79
C _U	15.74	C _C	1.33

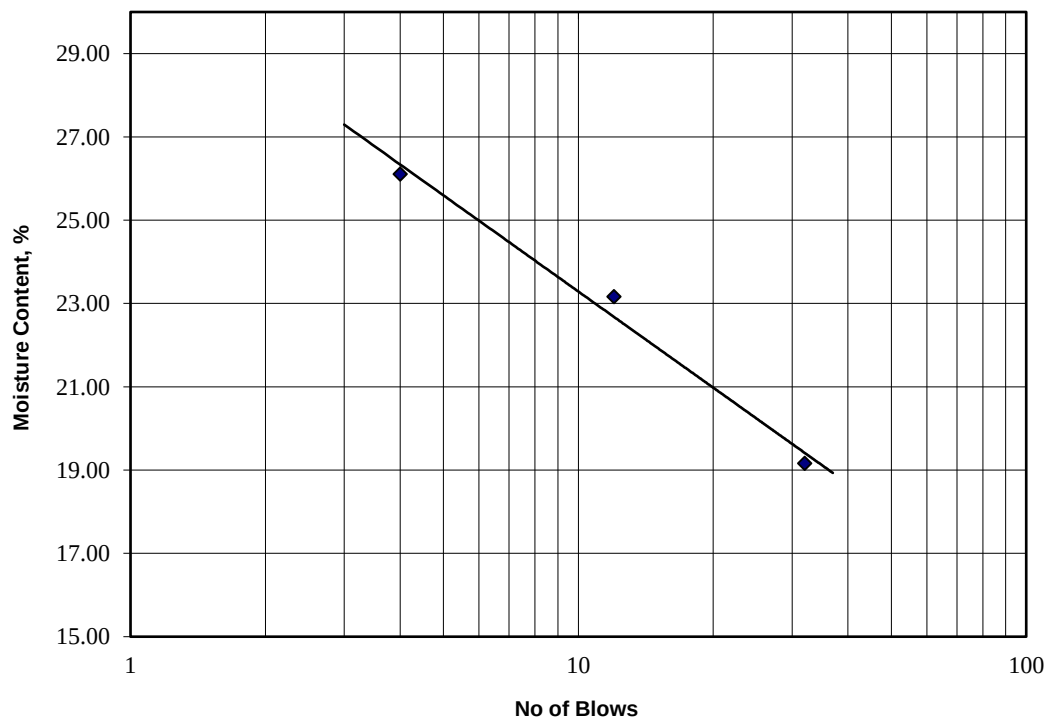
LIQUID LIMIT & PLASTIC LIMIT

Project: Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
 Location: Kaski and Tanahun Districts

Sample : SPT
 Borehole No. : 1

Depth m : 1.5+3

		Liquid Limit				Plastic Limit	
1	Specimen No.	1	2	3		1	2
2	No. of Blows	4	12	32			
3	Wt. of Container + Wet Soil gms	27.70	20.97	43.96		9.25	8.97
4	Wt. of Container + Dry Soil gms	23.47	18.01	38.11		9.02	8.61
5	Wt. of Water Present gms	4.23	2.96	5.85		0.23	0.36
6	Wt. of Empty Container gms	7.27	5.23	7.58		7.54	6.58
7	Wt. of Dry Soil gms	16.20	12.78	30.53		1.48	2.03
8	Moisture Content %	26.11	23.16	19.16		15.54	17.73



Results :

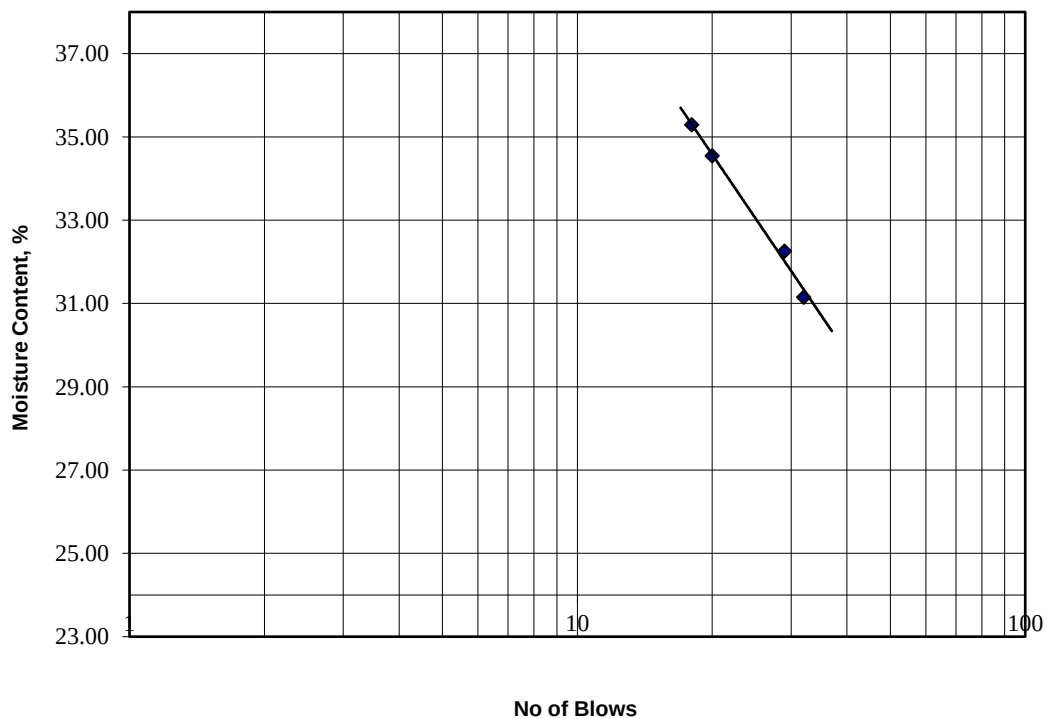
Liquid Limit : 20.2
 Plastic Limit : 15.5
 Plasticity Index : 4.7

LIQUID LIMIT & PLASTIC LIMIT

Project: Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
 Location: Kaski and Tanahun Districts

Sample : SPT
 Borehole No. : 5
 Depth m : 1.5+3

		Liquid Limit				Plastic Limit	
1	Specimen No.	1	2	3	4	1	2
2	No. of Blows	18	20	29	32		
3	Wt. of Container + Wet Soil gms	30.60	29.00	41.20	29.70	24.10	24.30
4	Wt. of Container + Dry Soil gms	28.20	27.10	39.20	27.80	23.60	23.70
5	Wt. of Water Present gms	2.40	1.90	2.00	1.90	0.50	0.60
6	Wt. of Empty Container gms	21.40	21.60	33.00	21.70	21.80	21.60
7	Wt. of Dry Soil gms	6.80	5.50	6.20	6.10	1.80	2.10
8	Moisture Content %	35.29	34.55	32.26	31.15	27.78	28.57



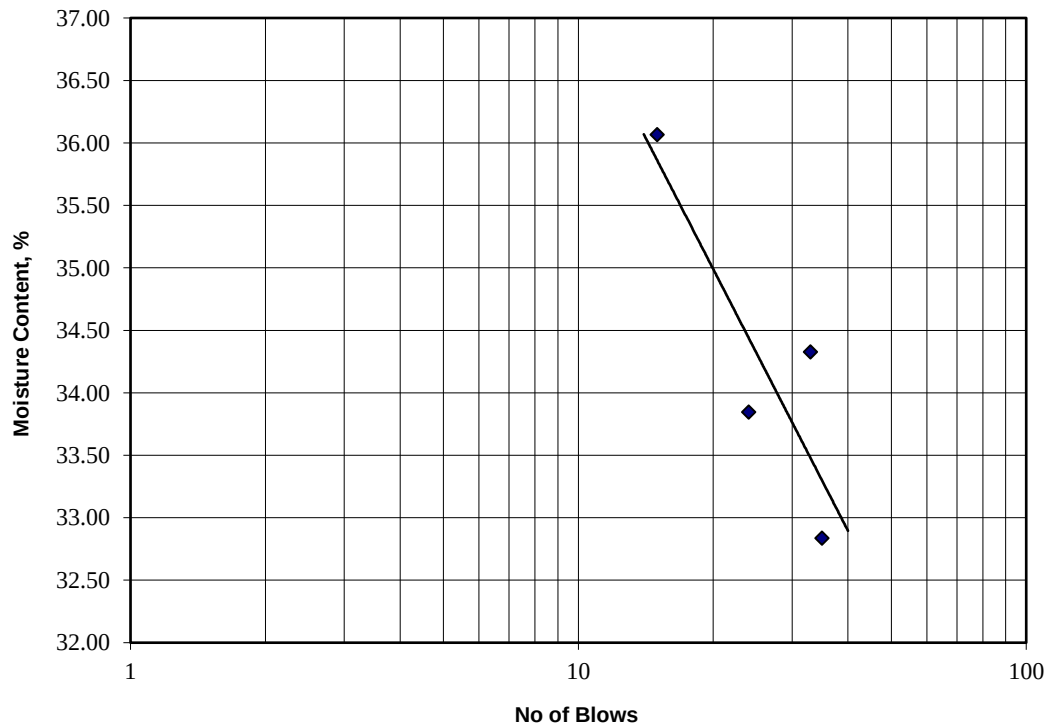
Results :
 Liquid Limit : 33.0
 Plastic Limit : 27.8
 Plasticity Index : 5.3

LIQUID LIMIT & PLASTIC LIMIT

Project: Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
 Location: Kaski and Tanahun Districts

Sample : SPT
 Borehole No. : 5
 Depth m : 4.5+6

		Liquid Limit				Plastic Limit	
1	Specimen No.	1	2	3	4	1	2
2	No. of Blows	15	24	33	35		
3	Wt. of Container + Wet Soil gms	30.30	30.40	30.20	30.80	23.40	23.80
4	Wt. of Container + Dry Soil gms	28.10	28.20	27.90	28.60	23.05	23.30
5	Wt. of Water Present gms	2.20	2.20	2.30	2.20	0.35	0.50
6	Wt. of Empty Container gms	22.00	21.70	21.20	21.90	21.80	21.70
7	Wt. of Dry Soil gms	6.10	6.50	6.70	6.70	1.25	1.60
8	Moisture Content %	36.07	33.85	34.33	32.84	28.00	31.25



Results :

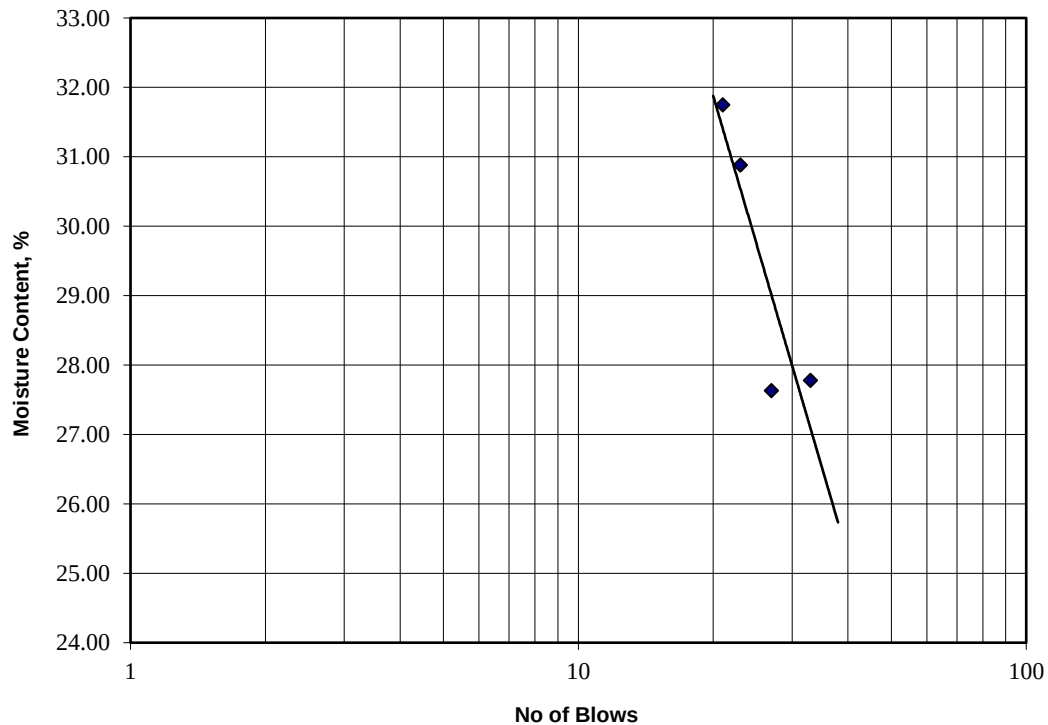
Liquid Limit : 34.3
 Plastic Limit : 28.0
 Plasticity Index : 6.3

LIQUID LIMIT & PLASTIC LIMIT

Project: Geotechnical Investigation of Proposed Sites of Substations and Transmission Lines
 Location: Kaski and Tanahun Districts

Sample : SPT
 Borehole No. : 7
 Depth m : 1.5+3

		Liquid Limit				Plastic Limit	
1	Specimen No.	1	2	3	4	1	2
2	No. of Blows	21	23	27	33		
3	Wt. of Container + Wet Soil gms	17.00	17.80	18.90	18.00	23.40	23.80
4	Wt. of Container + Dry Soil gms	15.00	15.70	16.80	16.00	23.10	23.30
5	Wt. of Water Present gms	2.00	2.10	2.10	2.00	0.30	0.50
6	Wt. of Empty Container gms	8.70	8.90	9.20	8.80	21.80	21.70
7	Wt. of Dry Soil gms	6.30	6.80	7.60	7.20	1.30	1.60
8	Moisture Content %	31.75	30.88	27.63	27.78	23.08	31.25



Results :

Liquid Limit : 29.7
 Plastic Limit : 23.1
 Plasticity Index : 6.7

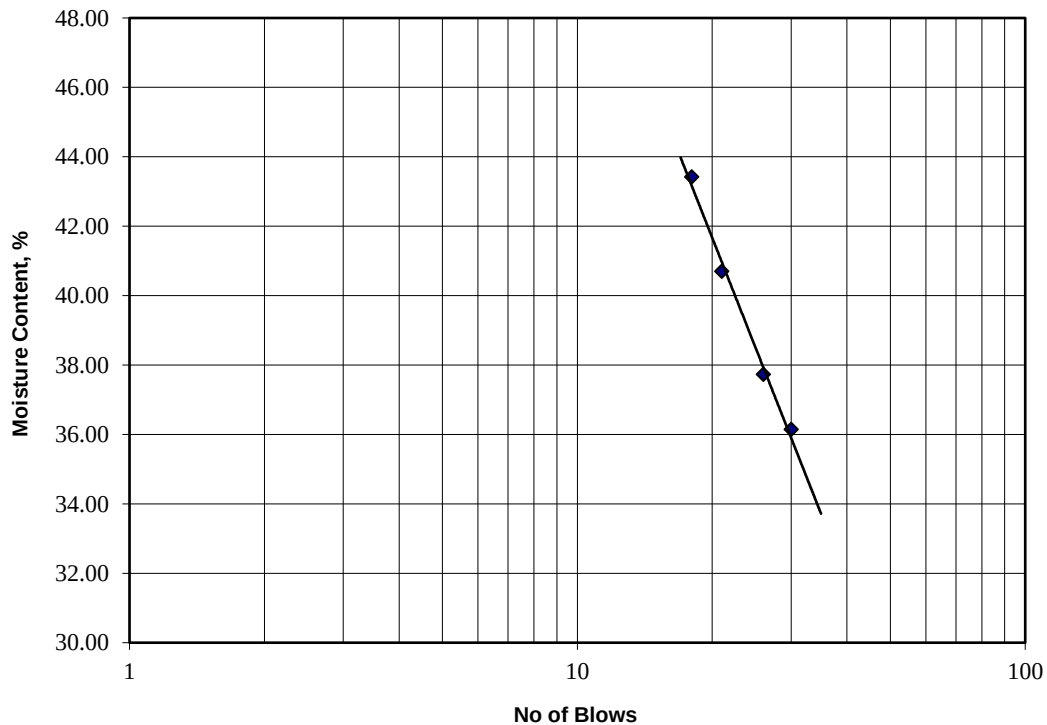
LIQUID LIMIT & PLASTIC LIMIT

Project: Geotechnical Investigation of Proposed Site
 Location: Kaski

Sample No. : SPT
 Borehole No. : 3

Depth m : 1.5

		Liquid Limit				Plastic Limit	
1	Specimen No.	1	2	3	4	1	2
2	No. of Blows	30	26	21	18		
3	Wt. of Container + Wet Soil gms	27.20	25.63	24.22	25.85	10.21	10.74
4	Wt. of Container + Dry Soil gms	25.70	24.40	23.52	24.20	9.90	10.30
5	Wt. of Water Present gms	1.50	1.23	0.70	1.65	0.31	0.44
6	Wt. of Empty Container gms	21.55	21.14	21.80	20.40	8.94	8.96
7	Wt. of Dry Soil gms	4.15	3.26	1.72	3.80	0.96	1.34
8	Moisture Content %	36.14	37.73	40.70	43.42	32.29	32.84



Results :

Liquid Limit : 38.5
 Plastic Limit : 32.3
 Plasticity Index : 6.2

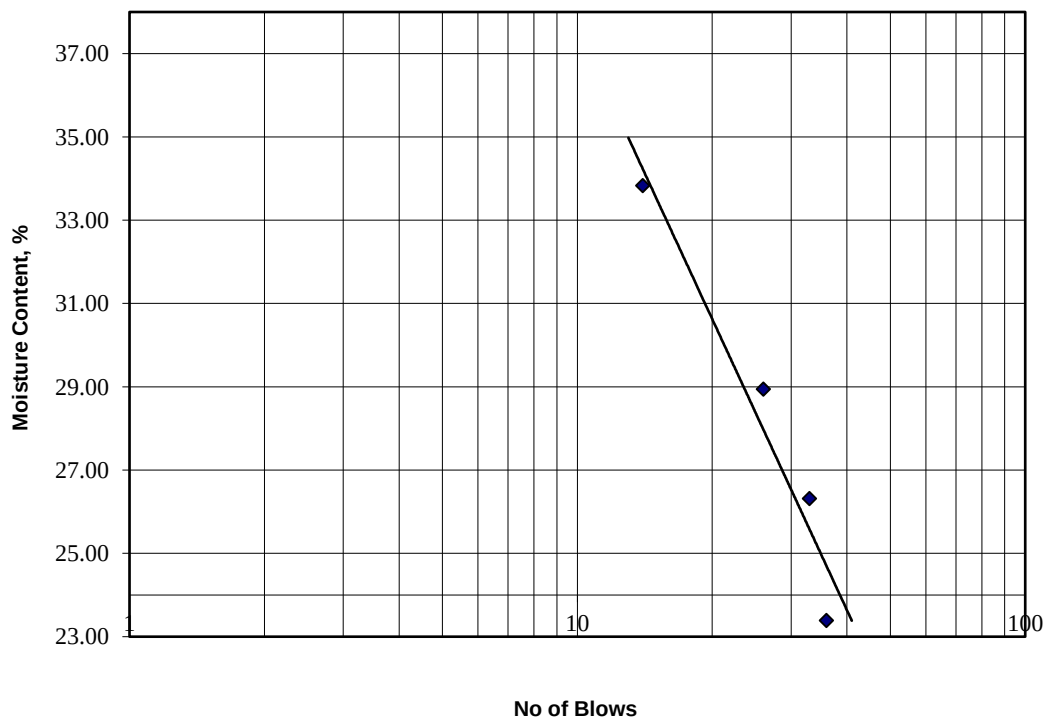
LIQUID LIMIT & PLASTIC LIMIT

Project: Geotechnical Investigation of Proposed Site
 Location: Kaski

Sample No. : SPT
 Borehole No. : 3

Depth m : 4.5

		Liquid Limit				Plastic Limit	
1	Specimen No.	1	2	3	4	1	2
2	No. of Blows	14	26	33	36		
3	Wt. of Container + Wet Soil gms	25.90	26.41	39.42	25.92	10.28	10.44
4	Wt. of Container + Dry Soil gms	24.99	25.42	38.52	25.12	10.00	10.20
5	Wt. of Water Present gms	0.91	0.99	0.90	0.80	0.29	0.24
6	Wt. of Empty Container gms	22.30	22.00	35.10	21.70	8.70	9.20
7	Wt. of Dry Soil gms	2.69	3.42	3.42	3.42	1.30	1.00
8	Moisture Content %	33.83	28.95	26.32	23.39	22.01	24.00



Results :

Liquid Limit : 28.4
 Plastic Limit : 22.0
 Plasticity Index : 6.4

DIRECT SHEAR TEST

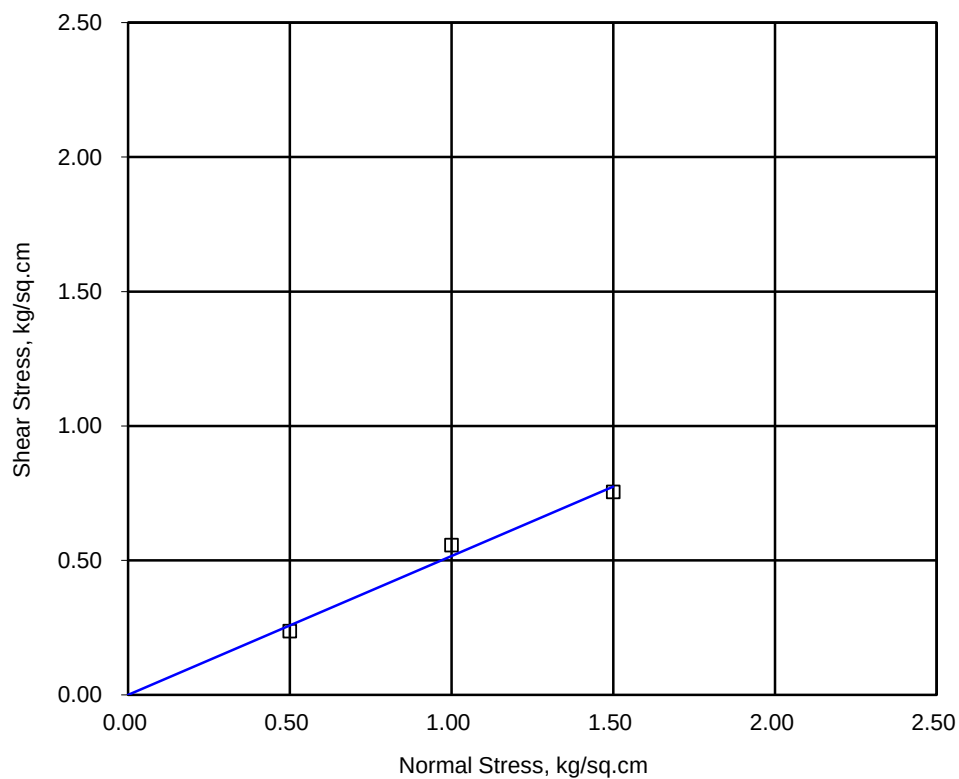
Project: Geotechnical Investigation of Proposed Substation Site
 Client: Nepal Electricity Authority
 Location: Damauli, Tanahun

Depth , m: 3.00
 Borehole No.: 1 - NEW

SDT cm	Test No. 1		Test No. 2		Test No. 3	
	Normal Stress 0.5 kg/cm ²		Normal Stress 1.0 kg/cm ²		Normal Stress 1.5 kg/cm ²	
	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²
0.1	23.00	0.101	54.00	0.237	87.00	0.382
0.2	34.00	0.149	67.00	0.294	105.00	0.461
0.3	46.00	0.202	73.00	0.320	112.00	0.491
0.4	54.00	0.237	88.00	0.386	125.00	0.548
0.5	53.00	0.232	96.00	0.421	133.00	0.583
0.6			105.00	0.461	145.00	0.636
0.7			113.00	0.496	156.00	0.684
0.8			127.00	0.557	159.00	0.697
0.9					168.00	0.737
1.0					172.00	0.754
1.1					170.00	0.746
1.2						
1.3						
1.4						
1.5						

SDT = Shear Displacement; PRDRg = Proving Ring Dial Reading; SST = Shear Stress

$$\phi = 27^{\circ}$$



DIRECT SHEAR TEST

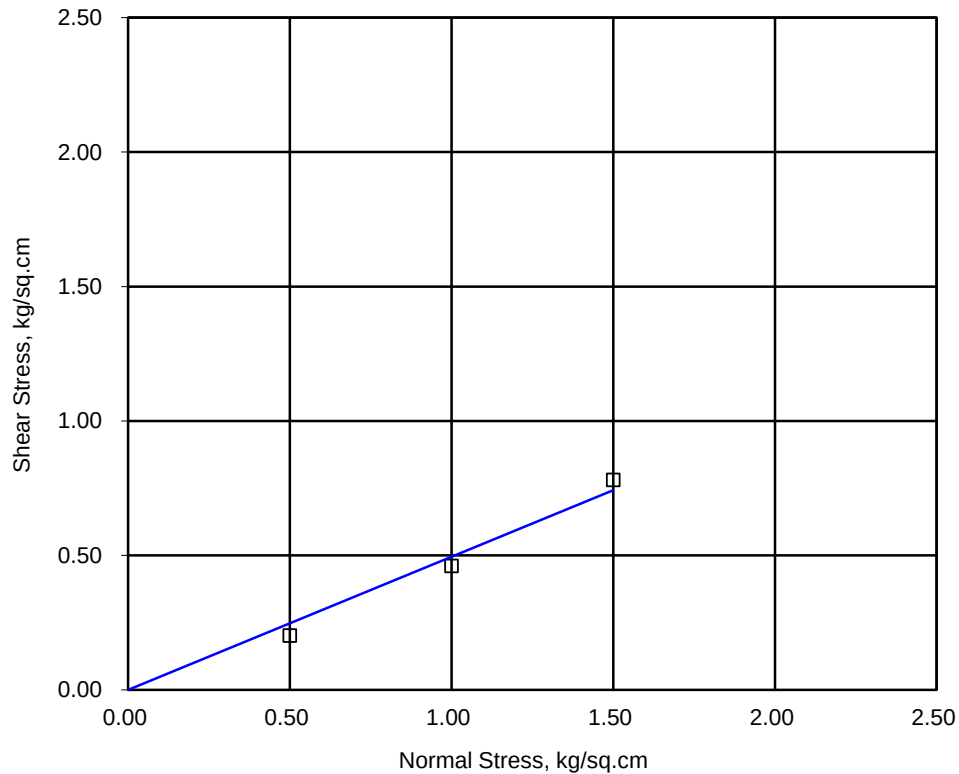
Project: Geotechnical Investigation of Proposed Substation Site
 Client: Nepal Electricity Authority
 Location: Damauli, Tanahun

Depth , m: 4.50
 Borehole No.: 1 - NEW

SDT cm	Test No. 1		Test No. 2		Test No. 3	
	Normal Stress 0.5 kg/cm ²		Normal Stress 1.0 kg/cm ²		Normal Stress 1.5 kg/cm ²	
	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²
0.1	19.00	0.083	55.00	0.241	78.00	0.342
0.2	23.00	0.101	68.00	0.298	92.00	0.404
0.3	33.00	0.145	78.00	0.342	104.00	0.456
0.4	46.00	0.202	85.00	0.373	113.00	0.496
0.5	45.00	0.197	96.00	0.421	127.00	0.557
0.6			105.00	0.461	133.00	0.583
0.7			103.00	0.452	145.00	0.636
0.8					156.00	0.684
0.9					168.00	0.737
1.0					178.00	0.781
1.1					176.00	0.772
1.2						
1.3						
1.4						
1.5						

SDT = Shear Displacement; PRDRg = Proving Ring Dial Reading; SST = Shear Stress

$$\phi = 26^\circ$$



DIRECT SHEAR TEST

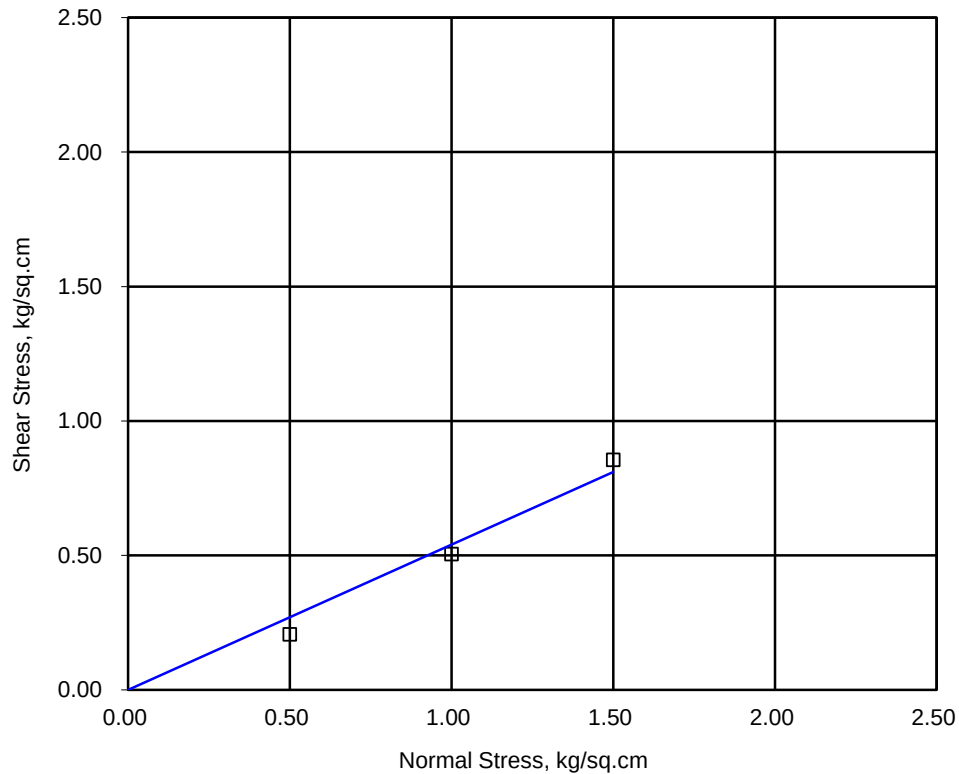
Project: Geotechnical Investigation of Proposed Substation Site
 Client: Nepal Electricity Authority
 Location: Damauli, Tanahun

Depth , m: 1.50
 Borehole No.: 2 - NEW

SDT cm	Test No. 1		Test No. 2		Test No. 3	
	Normal Stress 0.5 kg/cm ²		Normal Stress 1.0 kg/cm ²		Normal Stress 1.5 kg/cm ²	
	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²
0.1	27.00	0.118	62.00	0.272	94.00	0.412
0.2	33.00	0.145	78.00	0.342	113.00	0.496
0.3	47.00	0.206	85.00	0.373	126.00	0.553
0.4	45.00	0.197	96.00	0.421	137.00	0.601
0.5			107.00	0.469	145.00	0.636
0.6			115.00	0.504	158.00	0.693
0.7			113.00	0.496	167.00	0.732
0.8					178.00	0.781
0.9					187.00	0.820
1.0					195.00	0.855
1.1					193.00	0.846
1.2						
1.3						
1.4						
1.5						

SDT = Shear Displacement; PRDRg = Proving Ring Dial Reading; SST = Shear Stress

$$\phi = 28^{\circ}$$



DIRECT SHEAR TEST

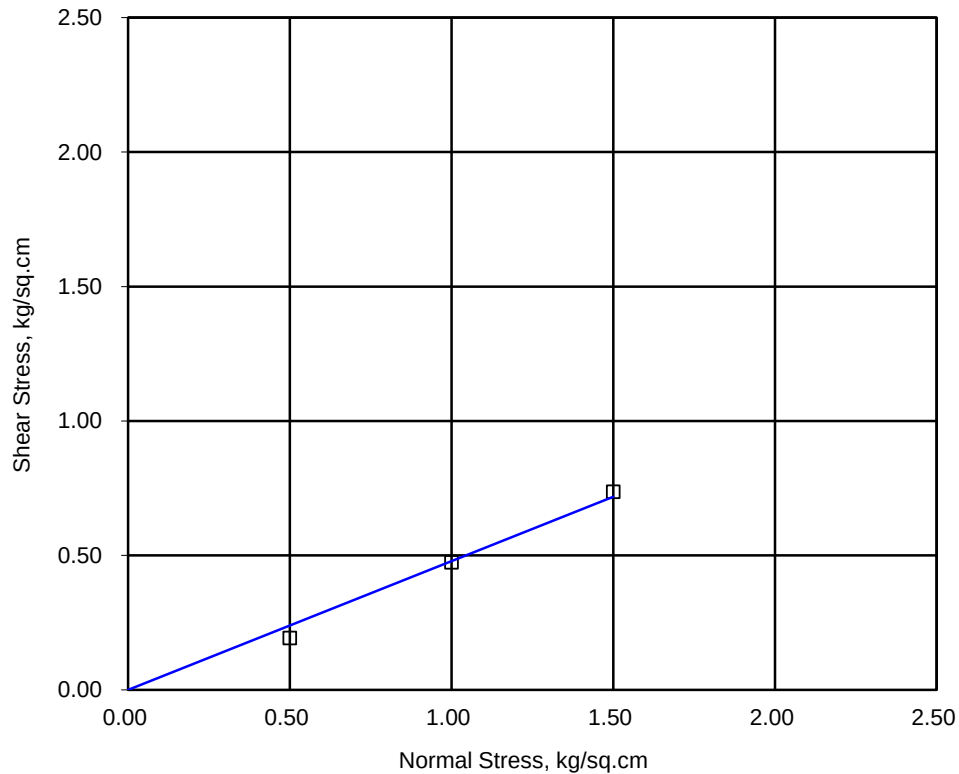
Project: Geotechnical Investigation of Proposed Substation Site
 Client: Nepal Electricity Authority
 Location: Damauli, Tanahun

Depth , m: 3.00
 Borehole No.: 2 - NEW

SDT cm	Test No. 1		Test No. 2		Test No. 3	
	Normal Stress 0.5 kg/cm ²		Normal Stress 1.0 kg/cm ²		Normal Stress 1.5 kg/cm ²	
	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²
0.1	25.00	0.110	65.00	0.285	87.00	0.382
0.2	38.00	0.167	79.00	0.346	105.00	0.461
0.3	44.00	0.193	82.00	0.360	113.00	0.496
0.4	42.00	0.184	96.00	0.421	126.00	0.553
0.5			108.00	0.474	133.00	0.583
0.6			105.00	0.461	145.00	0.636
0.7					156.00	0.684
0.8					164.00	0.719
0.9					168.00	0.737
1.0					166.00	0.728
1.1						
1.2						
1.3						
1.4						
1.5						

SDT = Shear Displacement; PRDRg = Proving Ring Dial Reading; SST = Shear Stress

$$\phi = 26^{\circ}$$



DIRECT SHEAR TEST

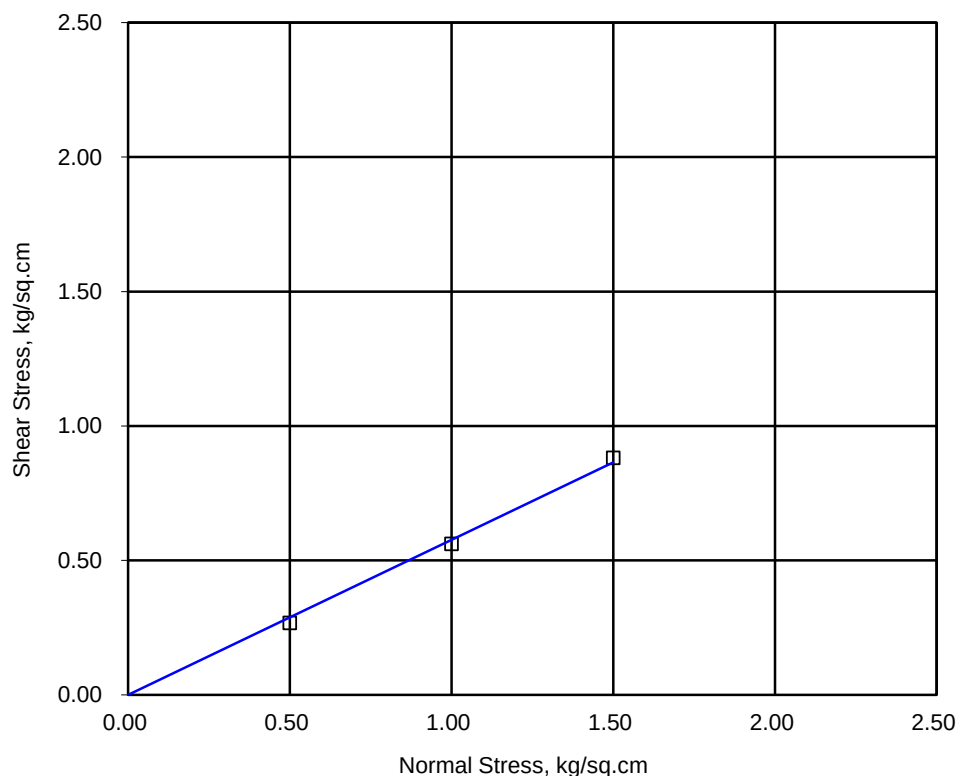
Project: Geotechnical Investigation of Proposed Substation Site
 Client: Nepal Electricity Authority
 Location: Damauli, Tanahun

Depth , m: 1.50
 Borehole No.: 3 - NEW

SDT cm	Test No. 1		Test No. 2		Test No. 3	
	Normal Stress 0.5 kg/cm ²		Normal Stress 1.0 kg/cm ²		Normal Stress 1.5 kg/cm ²	
	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²
0.1	19.00	0.083	57.00	0.250	95.00	0.417
0.2	23.00	0.101	65.00	0.285	113.00	0.496
0.3	45.00	0.197	78.00	0.342	125.00	0.548
0.4	61.00	0.268	85.00	0.373	133.00	0.583
0.5	52.00	0.228	99.00	0.434	148.00	0.649
0.6			112.00	0.491	156.00	0.684
0.7			128.00	0.561	167.00	0.732
0.8			122.00	0.535	175.00	0.768
0.9					188.00	0.825
1.0					201.00	0.882
1.1					192.00	0.842
1.2						
1.3						
1.4						
1.5						

SDT = Shear Displacement; PRDRg = Proving Ring Dial Reading; SST = Shear Stress

$$\phi = 30^{\circ}$$



DIRECT SHEAR TEST

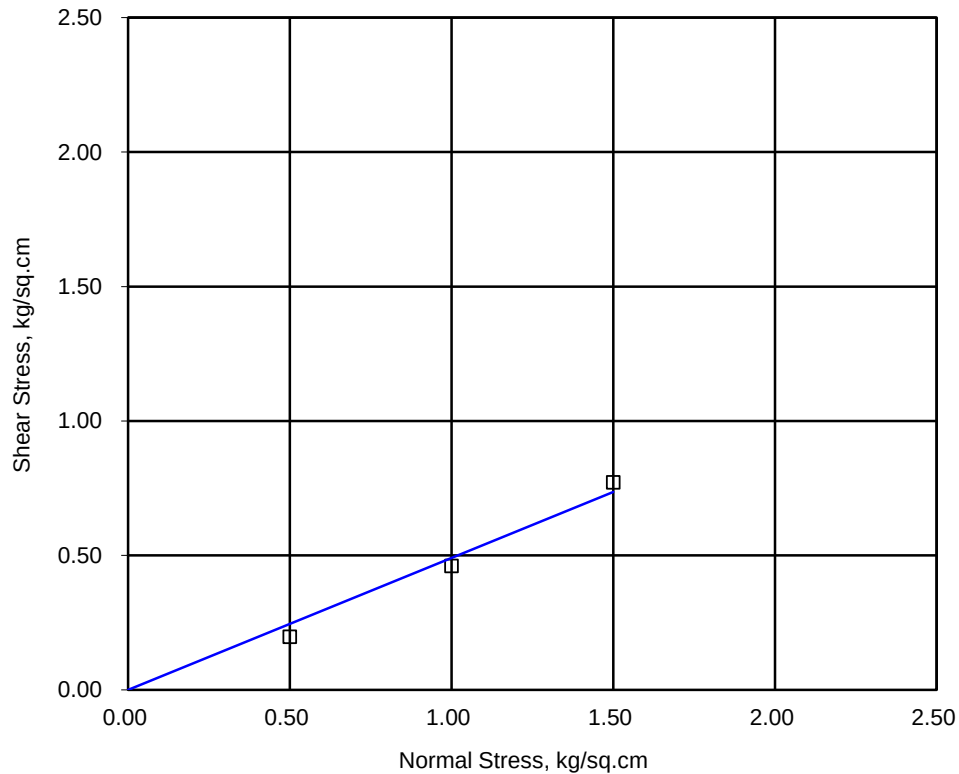
Project: Geotechnical Investigation of Proposed Substation Site
 Client: Nepal Electricity Authority
 Location: Damauli, Tanahun

Depth , m: 4.50
 Borehole No.: 3 - NEW

SDT cm	Test No. 1		Test No. 2		Test No. 3	
	Normal Stress 0.5 kg/cm ²		Normal Stress 1.0 kg/cm ²		Normal Stress 1.5 kg/cm ²	
	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²
0.1	27.00	0.118	68.00	0.298	87.00	0.382
0.2	33.00	0.145	76.00	0.333	105.00	0.461
0.3	45.00	0.197	84.00	0.368	113.00	0.496
0.4	43.00	0.189	97.00	0.425	125.00	0.548
0.5			105.00	0.461	133.00	0.583
0.6			101.00	0.443	145.00	0.636
0.7					156.00	0.684
0.8					168.00	0.737
0.9					175.00	0.768
1.0					176.00	0.772
1.1						
1.2						
1.3						
1.4						
1.5						

SDT = Shear Displacement; PRDRg = Proving Ring Dial Reading; SST = Shear Stress

$$\phi = 26^\circ$$



DIRECT SHEAR TEST

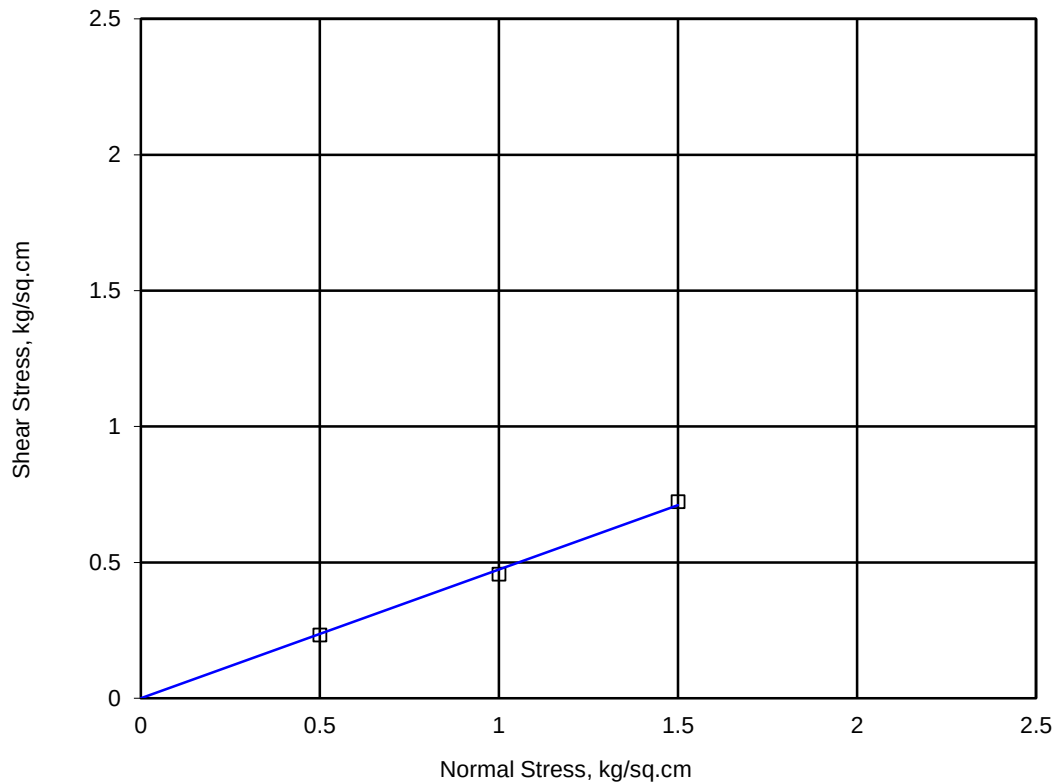
Project: Geotechnical Investigation of Proposed Substation Site
 Client: Nepal Electricity Authority
 Location: Damauli, Tanahun

Depth , m: 3.0
 Borehole No.: 4- NEW

SDT cm	Test No. 1		Test No. 2		Test No. 3	
	Normal Stress 0.5 kg/cm ²		Normal Stress 1.0 kg/cm ²		Normal Stress 1.5 kg/cm ²	
	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²
0.1	16.00	0.070	57.00	0.250	87.00	0.382
0.2	23.00	0.101	72.00	0.316	104.00	0.456
0.3	38.00	0.167	86.00	0.377	113.00	0.496
0.4	52.00	0.228	95.00	0.417	126.00	0.553
0.5	47.00	0.206	112.00	0.491	133.00	0.583
0.6			123.00	0.539	145.00	0.636
0.7			121.00	0.531	158.00	0.693
0.8					178.00	0.781
0.9					192.00	0.842
1.0					202.00	0.886
1.1					200.00	0.877
1.2						
1.3						
1.4						
1.5						

SDT = Shear Displacement; PRDRg = Proving Ring Dial Reading; SST = Shear Stress

$\phi = 30^\circ$



DIRECT SHEAR TEST

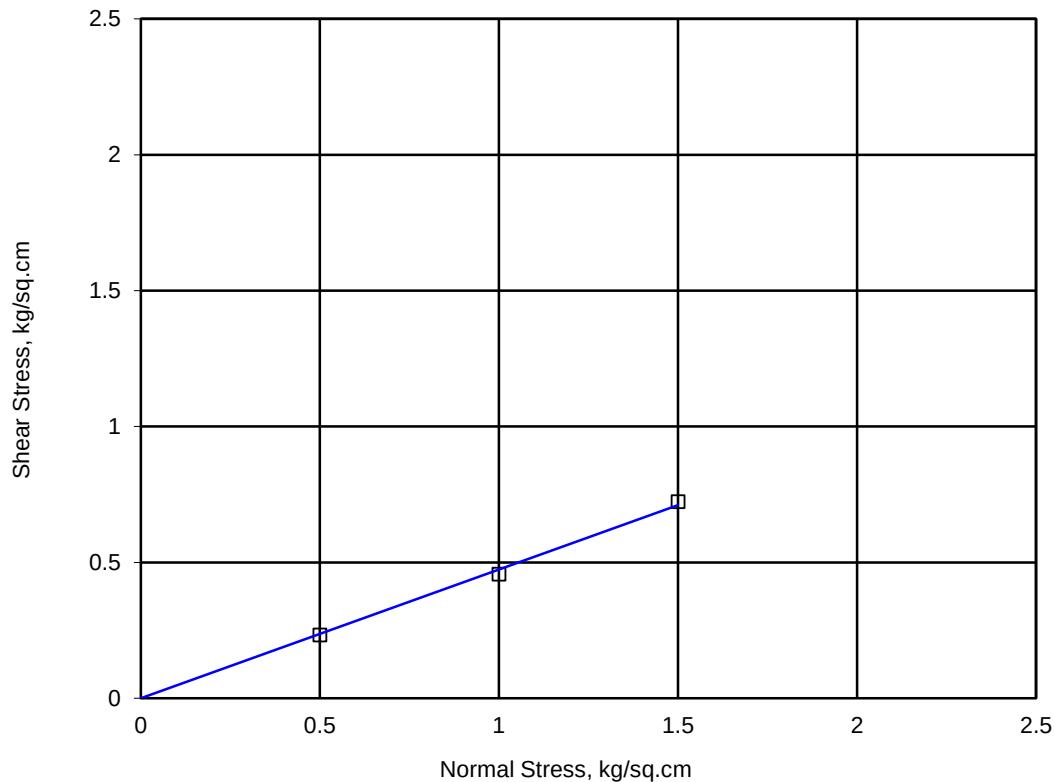
Project: Geotechnical Investigation of Proposed Substation Site
 Client: Nepal Electricity Authority
 Location: Damauli, Tanahun

Depth , m: 6.0
 Borehole No.: 4- NEW

SDT cm	Test No. 1		Test No. 2		Test No. 3	
	Normal Stress 0.5 kg/cm ²		Normal Stress 1.0 kg/cm ²		Normal Stress 1.5 kg/cm ²	
	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²	PRDRg	SST kg/cm ²
0.1	27.00	0.118	52.00	0.228	95.00	0.417
0.2	38.00	0.167	68.00	0.298	112.00	0.491
0.3	56.00	0.246	78.00	0.342	126.00	0.553
0.4	51.00	0.224	86.00	0.377	134.00	0.588
0.5			99.00	0.434	145.00	0.636
0.6			109.00	0.478	162.00	0.711
0.7			104.00	0.456	179.00	0.785
0.8					188.00	0.825
0.9					204.00	0.895
1.0					210.00	0.921
1.1					204.00	0.895
1.2						
1.3						
1.4						
1.5						

SDT = Shear Displacement; PRDRg = Proving Ring Dial Reading; SST = Shear Stress

$\phi = 30^\circ$



ANNEX-III
PHOTOGRAPHS

BOREHOLE -01



Conduction of Standard Penetration Test at Depth 1.5m



Conduction of Standard Penetration Test at Depth 6.0 m



Standard Penetration Test Sample at 1.5 m



Standard Penetration Test Sample at 6.0 m

BOREHOLE -02



Test scratches at site



Conduction of Standard Penetration Test



Standard Penetration Test at Site at depth of 1.5 m

BOREHOLE -03 – NEW – TRANSMISSION TOWER



Excavation of Trial Pits in Transmission Tower Location BH 3



Augering in Process in Transmission Tower BH 3



Augering in Process in Transmission Tower BH 3

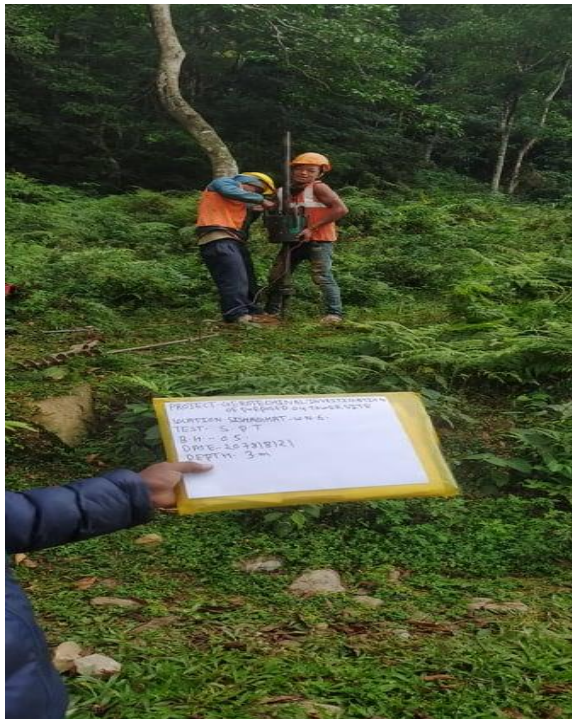


Soil Sample in Split Spoon Sampler of Transmission Tower BH 3

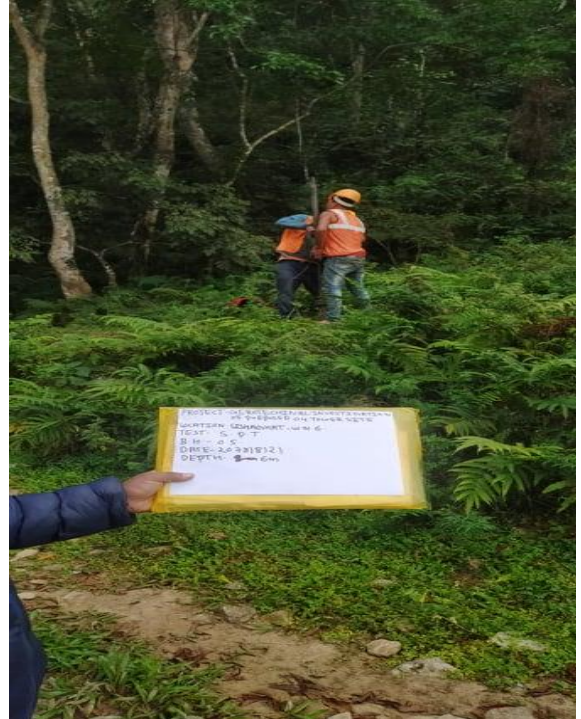


Conduction of Standard Penetration Test in Transmission Tower BH 3

BOREHOLE -04



Conduction of Standard Penetration Test at Depth 3.0m



Conduction of Standard Penetration Test at Depth 6.0 m



Standard Penetration Test Sample at 6.0m

BOREHOLE -05



Drilling by Auger



Conduction of Standard Penetration Test at Depth 4.5 m

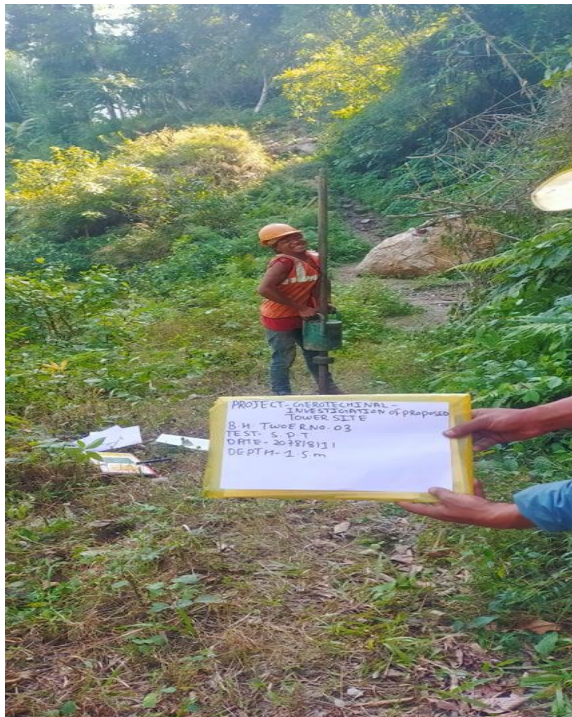


Conduction of Standard Penetration Test at Depth 6.0 m



Standard Penetration Test Sample at 3.0m

BOREHOLE -06



Conduction of Standard Penetration Test at Depth 1.5 m



Standard Penetration Test Sample at 1.5m

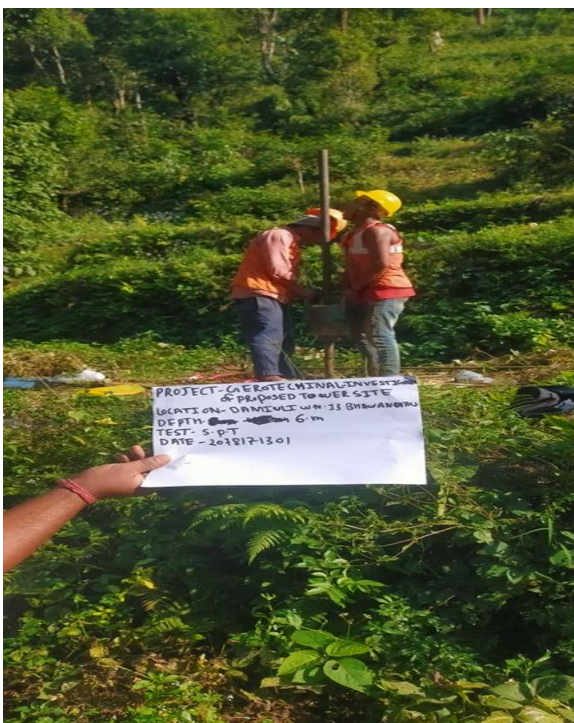
BOREHOLE -07



Conduction of Standard Penetration Test at Depth 3.0 m



Conduction of Standard Penetration Test at Depth 4.5 m



Conduction of Standard Penetration Test at Depth 6.0 m



Standard Penetration Test Sample at 6.0m

BOREHOLE -08 (DAMAULI SUBSTATION)



Conduction of Dynamic Cone Penetration Test at Depth 6.0 m



Conduction of Standard Penetration Test at Depth 9.0 m



Conduction of Dynamic Cone Penetration Test at Depth 15.0 m



Standard Penetration Test Sample at 9.0m

BOREHOLE -09 (LEKHNATH SUBSTATION)



Conduction of Dynamic Cone Penetration Test at Depth 3.0 m



Conduction of Dynamic Cone Penetration Test at Depth 4.5 m



Conduction of Dynamic Cone Penetration Test at Depth 6.0 m



Core Sample 0-5.0m



Core Sample 5.0-10.0m



Core Sample 10.0-15.0m

BOREHOLE – 1 TO 4 (NEW) (DAMAULI SUBSTATION)



Conduction of Standard Penetration Test at New Borehole 1 of Damauli SS; Depth 4.5 m



Conduction of Dynamic Cone Penetration Test at New Borehole 1 of Damauli SS; Depth 15 m



Conduction of Standard Penetration Test at New Borehole 2 of Damauli SS; Depth 1.5 m



Conduction of Standard Penetration Test at New Borehole 2 of Damauli SS; Depth 7.5 m



Conduction of Standard Penetration Test at New Borehole 3 of Damauli SS; Depth 7.5 m



Conduction of Dynamic Cone Penetration Test at New Borehole 3 of Damauli SS; Depth 15 m



Conduction of Standard Penetration Test at New Borehole 4 of Damauli SS; Depth 3 m



Conduction of Dynamic Cone Penetration Test at New Borehole 4 of Damauli SS; Depth 13.5 m



Soil Sample in Split Spoon Sampler of New Borehole 1 of Damauli SS; Depth 1.5 m



Soil Sample in Split Spoon Sampler of New Borehole 1 of Damauli SS; Depth 3 m



Soil Sample in Split Spoon Sampler of New Borehole 1 of Damauli SS; Depth 4.5 m



Soil Sample in Split Spoon Sampler of New Borehole 1 of Damauli SS; Depth 9 m



Soil Sample in Split Spoon Sampler of New Borehole 3 of Damauli SS; Depth 3 m



Soil Sample in Split Spoon Sampler of New Borehole 3 of Damauli SS; Depth 4.5 m



Soil Sample in Split Spoon Sampler of New Borehole 3 of Damauli SS; Depth 9 m



Soil Sample in Split Spoon Sampler of New Borehole 4 of Damauli SS; Depth 7.5 m



Soil Sample in Split Spoon Sampler of New Borehole 4 of Damauli SS; Depth 9 m



Soil Sample in Split Spoon Sampler of New Borehole 4 of Damauli SS; Depth 3 m

ANNEX-IV

FORMAT OF ANALYSIS

BOREHOLE 1					
S. No.	Depth	DCPT		SPT (N)	Observed SPT
	(m)	no. of blows	penetration (cm)		
	0				
1	1.5			34	34
2	3			36	36
3	4.5			40	40
4	6			47	47

NCEER-1998: Youd et al. 2001

Correction to SPT (Modified from Skempton 1986) as listed by Robertson and Wride (1998)

Factor (1)	Equipment variable (2)	Term (3)	Correction (4)
Overburden pressure	—	C_N	$(P_a/\sigma'_{vm})^{0.5}$
Overburden pressure	—	C_N	$C_N \leq 1.7$
Energy ratio	Donut hammer	C_E	0.5–1.0
Energy ratio	Safety hammer	C_E	0.7–1.2
Energy ratio	Automatic-trip Donut-type hammer	C_E	0.8–1.3
Borehole diameter	65–115 mm	C_B	1.0
Borehole diameter	150 mm	C_B	1.05
Borehole diameter	200 mm	C_B	1.15
Rod length	<3 m	C_R	0.75
Rod length	3–4 m	C_R	0.8
Rod length	4–6 m	C_R	0.85
Rod length	6–10 m	C_R	0.95
Rod length	10–30 m	C_R	1.0
Sampling method	Standard sampler	C_S	1.0
Sampling method	Sampler without liners	C_S	1.1–1.3

Borehole Diameter (mm)= 76									
Sampler type = Standard									
Sampling method (Standard=1, without liner=1.1-1.3)									
BOREHOLE BOREHOLE 1									
					Correction for				
S.No.	Depth (m)	Measured (N)		Rod length (m)	Energy Ratio (C_E)	Borehole diameter (C_B)	Rod length (C_R)	Sampler type (C_S)	N_{60}
1	1.5	34		2.7	0.92	1	0.75	1	23
2	3	36		4.2	0.92	1	0.85	1	28
3	4.5	40		5.7	0.92	1	0.85	1	31
4	6	47		7.2	0.92	1	0.95	1	41

Note: $E_m = 0.55$ for hand drop hammer; is the rod energy ratio for hammer used in the investigation, due to lack of true verticalness and proper speed of SPT blow (Kovacs 1983)

BOREHOLE 1						
Description	Unit	Symbol	Data			
Soil Unit Weight	kN/m^3	g	17	17	17	17
Depth to WT (Critical)	m	D _w	0	0	0	0
Submerged Unit Weight	kN/m^3	g_{sub}	7.19	7.19	7.19	7.19
Adopted observed SPT Value	-	N	23	28	31	41
Depth	m	D	1.5	3.0	4.5	6.0
Effective Overburden Pressure	kN/m^2	p_0'	11	22	32	43
Correction Factor	-	C_N	1.75	1.51	1.38	1.28
N-Value after Overburden correction	-	N'	40	42	43	53
N-Value after Dilatancy correction	-	N''	28	29	29	34

BOREHOLE 1							
Depth,m	1.5	3	4.5	6			
Corrected N-value	28	29	29	34			
ISOLATED FOOTING - N-VALUE							
Depth (D _f ,m)				1.50			
Width (B, m)	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length (L, m)	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Effective Depth	4.5	5.5	6.0	6.5	7.5	8.5	9.5
Ncorr	28	30	30	30	30	30	30
Adopted Ncorr	27.58						

Calculation of Bearing Capacity of Open Foundation

From Shear Failure Criteria (IS 6403-1981)

Bore Hole. No:	1						
Depth (D_f ,m)				1.50			
Depth of water table below GL (Z_w ,m)				0.00			
Unit wt of soil (KN/m^3)	17.00						
C (KN/m^2), FORMULA							
C (KN/m^2), LAB							
C (KN/m^2), For Design	0.00						
Width (B, m)	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Length (L, m)	1.50	2.00	2.25	2.50	3.00	3.50	4.00
Eccentricity along X- dirn (e_x ,m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eccentricity along Y- dirn (e_y ,m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corrected SPT Value (N_{cor})	27.58	27.58	27.58	27.58	27.58	27.58	27.58
Angle of Shearing Resistance (ϕ), FORMULA	33.19	33.19	33.19	33.19	33.19	33.19	33.19
Angle of Shearing Resistance (ϕ), LAB	-	-	-	-	-	-	-
Angle of shearing resistance (ϕ), For Design	33.19	33.19	33.19	33.19	33.19	33.19	33.19
Bearing Capacity factor (N_q)	26.71	26.71	26.71	26.71	26.71	26.71	26.71
Bearing Capacity factor (N_c)	39.29	39.29	39.29	39.29	39.29	39.29	39.29
Bearing Capacity factor (N_y)	36.23	36.23	36.23	36.23	36.23	36.23	36.23
Shape factor (S_c)	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Shapr factor (S_q)	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Shape factor (S_y)	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Sqrt ($N\phi$)	1.85	1.85	1.85	1.85	1.85	1.85	1.85
Depth factor (d_c)	1.37	1.28	1.25	1.22	1.18	1.16	1.14
Depth factor (d_q)	1.18	1.14	1.12	1.11	1.09	1.08	1.07
Depth factor (d_y)	1.18	1.14	1.12	1.11	1.09	1.08	1.07
qu	10.50						
Inclination factor (i_c)	1.00						
Inclination factor (i_q)	1.00						
Inclination factor (i_y)	1.00						
Correction for water table level (R_w)	0.00	0.13	0.17	0.20	0.25	0.29	0.31
Correction for water table level (R_{w2} , m)	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Net Ultimate Bearing Capacity (q_{ult} , KN/m^2)	602.71	649.33	675.13	701.93	757.53	814.84	873.22
Factor of Safety (FOS)	3.00						
Net Allowable Bearing Pressure (q_{na} , KN/m^2)	201	216	225	234	253	272	291

From Settlement Criteria (Meyerhoff's modified Method)- Bowle's 1982 method

Depth Correction (R_D)	1.33	1.25	1.22	1.20	1.17	1.14	1.12
Correction for water table level (R_{w2})	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Permissible settlement (mm)	20						
$q_{\text{safe-pr 20mm}}$ (KN/m^2)	264.15	227.55	216.13	207.27	194.43	185.58	179.11
Adopt Safe Bearing Capacity in KN/m^2 (For 20 mm Permissible Settlement)	201	216	216	207	194	186	179

BH 1	BH 2	BH 3	BH 4	BH 8
22	50	17	50	16
14	22	24	12	19
22	50	21	16	17
11	26	10	21	17
8	18	6	18	24
37	10	49	50	34
50	50	50	50	33
50	50	50	50	35
50	50	50	50	50
50	50	50	50	50

MODELLED STRATA- NEW BH 1, 2,3,4 & BH 8						
S. No.	Depth	DCPT		SPT (N)	Corelated SPT	Observed SPT
	(m)	no. of blows	penetr ation (cm)			
	0					
1	1.5			16	16	16
2	3			12	12	12
3	4.5			16	16	16
4	6			10	10	10
5	7.5			6	6	6
6	9			10	10	10
7	10.5			33	33	33
8	12			35	35	35
9	13.5			50	50	50
10	15			50	50	50

NCEER-1998: Youd et al. 2001
Correction to SPT (Modified from Skempton 1986) as listed by Robertson and Wride (1998)

Borehole Diameter (mm)= 96										
Sampler type = Standard										
Sampling method (Standard=1, without liner=1.1-1.3)										
BOREHOLE MODELLED STRATA- NEW BH 1, 2,3,4 & BH 8										
						Correction for				
S.No.	Depth (m)	Measured (N)			Rod length (m)	Energy Ratio (C_E)	Borehole diameter (C_B)	Rod length (C_R)	Sampler type (C_S)	N_{60}
1	1.5	16			2.7	0.92	1	0.75	1	11
2	3	12			4.2	0.92	1	0.85	1	9
3	4.5	16			5.7	0.92	1	0.85	1	13
4	6	10			7.2	0.92	1	0.95	1	9
5	7.5	6			8.7	0.92	1	0.95	1	5
6	9	10			10.2	0.92	1	1	1	9
7	10.5	33			11.7	0.92	1	1	1	30
8	12	35			13.2	0.92	1	1	1	32
9	13.5	50			14.7	0.92	1	1	1	46
10	15	50			16.2	0.92	1	1	1	46

S. No.	Depth	Correlated SPT	Lab data available (Y/N) ?	Data From Lab test		Soil Contain (C, Φ , C- Φ)	major soil type:	Stratum consists of fine sand or silty sand ? no(n)/yes(y)	Bulk Unit wt.	Submer ged unit weight	effective unit weight	Angle of Shearing Resistance	Undrained cohesion Cu	Total stress	Eff. stress	Overburden correction Factor (C _N)	(N ₁) ₆₀ after overburden correction	(N ₁) ₆₀ after dilatancy correction
	(m)			C _u	Φ°				KN/m ³	KN/m ³		Φ°	C _u	KN/m ²	KN/m ²			
1	1.5	11	N			Φ	S	y	17	10	7.0	29	0	30	11	1.8	19	17
2	3	9	N			Φ	S	y	17	10	7.0	27	0	60	21	1.5	13	13
3	4.5	13	N			Φ	S	y	17	10	7.0	29	0	90	32	1.4	18	17
4	6	9	N			Φ	S	y	17	10	7.0	26	0	120	42	1.3	11	11
5	7.5	5	N			Φ	S	y	17	10	7.0	23	0	150	53	1.2	6	6
6	9	9	N			Φ	S	y	17	10	7.0	26	0	180	63	1.2	10	10
7	10.5	30	N			Φ	G	y	17	10	7.0	34	0	210	74	1.1	33	24
8	12	32	N			Φ	G	y	17	10	7.0	34	0	240	84	1.1	33	24
9	13.5	46	N			Φ	G	y	17	10	7.0	36	0	270	95	1.0	46	31
10	15	46	N			Φ	G	y	17	10	7.0	36	0	300	105	1.0	45	30

ALLOWABLE BEARING CAPACITY OF BORED PILES IN SOIL

Type of Pile = Bored cast

Proposed length of Pile = 9 m

Dia of pile = 0.5 m

Pile Material = Concrete

GWT = 0 m

N_{q,base} = 48

N_c = 9

Restricts effective vertical stress = Yes

Effective vertical stress at pile base = 47.25 KN/m²

γ' = 7 KN/m³

Type of Consolidation = Normally

Critical depth = 19.7

σ_{0c}' = KN/m²

Over Consolidation Ratio = 2.5

Sand Type = Unknown

Limiting Friction (KN/m²) = 200000

Cross sectional Area of Pile = 0.20 m²

Undarined cohesion at pile base = 0 KN/m²

Liquefaction Considered = Yes

FoS against Liquefaction = 1

FoS against Bearing = 2.5

Assumed Scour Depth (m) = 1.5

Depth of Pile Top from normal ground level, m = 1.5

Depth of pile tip from normal ground level= 10.5

Angle of internal friction at pile tip= 35.00

Length of penetration of pile in the bearing strata, m= 9

																	Shaft Resistance			Base Resistance					Considering Liquefaction	
Layer	H	Soil Type	Le	N _{corrected}	φ	undrained cohesion Cu	effective unit weight	effective overburden pressure	effective overburden pressure	Shaft area A _s	wall friction δ	Beta (K tan δ)	Undrained cohesion (Cu)	Adhesion factor (alpha)	Skin friction using alpha method (KN/m2)	Skin friction using beta method (KN/m2)	Qs Shaft (alpha) KN	Qs Shaft (beta) KN	Qs Shaft KN	Qb (alpha) KN	Qb (beta) KN	Q _{b, base}	Total Resistance (KN)	FOS against Liquefaction	Qs Shaft (KN)	
						kN/m ²	kN/m ³	kN/m ²		m ²																
1.5	0	φ	0	17	29	0.0	7	11	11	0.00	21.96	0.21	0.00	0.00	0.00	2.16	0.00	0.00	0.00	0.00	442.19	442.19	554.09			
3	1.5	φ	1.5	13	27	0.0	7	21	21	2.36	20.62	0.20	0.00	0.00	0.00	4.25	0.00	10.02	10.02					1.50	0.00	
4.5	1.5	φ	3	17	29	0.0	7	32	32	2.36	21.80	0.21	0.00	0.00	0.00	6.48	0.00	15.26	15.26					0.80	0.00	
6	1.5	φ	4.5	11	26	0.0	7	42	42	2.36	19.87	0.20	0.00	0.00	0.00	8.41	0.00	19.81	19.81					0.80	0.00	
7.5	1.5	φ	6	6	23	0.0	7	53	47	2.36	17.61	0.19	0.00	0.00	0.00	9.02	0.00	21.26	21.26					0.80	0.00	
9	1.5	φ	7.5	10	26	0.0	7	63	47	2.36	19.47	0.20	0.00	0.00	0.00	9.39	0.00	22.13	22.13					0.80	0.00	
10.5	1.5	φ	9	24	34	0.0	7	74	47	2.36	25.76	0.21	0.00	0.00	0.00	9.94	0.00	23.41	23.41					1.50	23.41	
12	1.5	φ	10.5	24	34	0.0	7	84	47	0.00	25.76	0.21	0.00	0.00	0.00	9.94	0.00	0.00	0.00					1.50	0.00	
13.5	1.5	φ	12	31	36	0.0	7	95	47	0.00	27.14	0.21	0.00	0.00	0.00	9.92	0.00	0.00	0.00					1.50	0.00	
15	1.5	φ	13.5	30	36	0.0	7	105	47	0.00	27.04	0.21	0.00	0.00	0.00	9.92	0.00	0.00	0.00					1.50	0.00	
total Resistance (KN) =																0.00	111.90	111.90	0.00	442.19	442.19	554.09		23.41		

Decrease in Frictional resistance due to Liquefaction = 88.5 KN

Total Tip Resistance = 442.2 KN

Total Frictional resistance = 23.4 KN

Total Resistance = 465.6 KN

Allowable Bearing = 186.24 KN