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Geophysical Characterizations of Unconsolidated Sediments for Geotechnical Studies at Bhadrapur Municipality Area of South-east Nepal

[Poster No.: P2.2 - 704]

Bhandari R P, Shrestha S, Kandel T, Bhattarai M and BK Nabin

POSTER

Government of Nepal
Ministry of Industry, Commerce and Supplies
Department of Mines and Geology
National Data Center
Lainchaur, Kathmandu

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This scientific work is to enhance the capability of the Nepalese Data Center for optimizing the geophysical research not only in the seismic data acquisition and processing but also in various fields such as resistivity sounding, geo-radar measurements and interpretations which could be ultimately help in enhancing foundation safety as well as aiming to participate in on-site inspection campaign which could be run by CTBTO in the coming days where the nuclear explosion occurs.

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ABSTRACT

- Using geophysical techniques, estimated an engineering properties of the sediments that helps to minimize the risk of seismic hazard and the differential settlements of the static structures.
- Geophysical (seismic and electrical) with in-situ and laboratory geotechnical investigation have been performed.
- There exists correlation between the resistivity, shear wave velocity and the SPT-N value of the soil profile.
- Basically, the low velocity layer (200 m/s) correlated with low SPT count(4- 10 blows) and the low resistivity (< 100 ohm-m) with an exception of high resistivity (>1000 ohm-m) of dry top soil layer.
- High shear wave velocity layer (350 m/s) co-related with the high SPT (10 - >30 blow counts) and high resistivity (>1000 ohm m).

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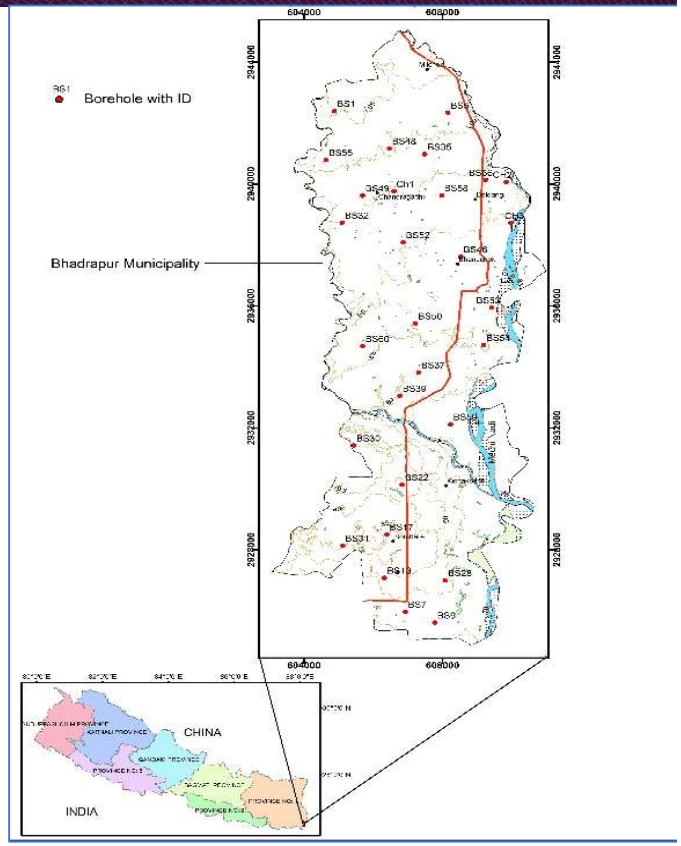
INTRODUCTION

- The area is located in the far eastern part of Nepal bordered to the east and south with India.
- Work conducted in approx. 100 sq. km area. 30 bore holes are sparsely distributed in entire Municipal area.
- The area consists of quaternary sediments of clay, silt, sand, gravel and boulders
- Engineering and index properties of soils investigated in the laboratory and SPT-N value, shear wave velocity and resistivity data were gathered from the field.
- Shallow groundwater table lies around 3 m bgl.



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METHODS

- Resistivity of the subsurface layer delineated by ***VES*** using GD 10 resistivity meter. Shear wave velocity of the layer determined by ***MASW*** and ***CCA*** method.
- ***SPT-N*** value were determined by 63 kg falling hammer to drive down to the 15 cm of soil profile.
- In situ soil properties such as moisture content were determined in the field.
- Undisturbed samples were taken to measure the properties of the soil in the laboratory.
- ***UCS, grain size analysis, density, specific gravity, direct shear tests*** performed in the laboratory

SPT tools under operation in the field.

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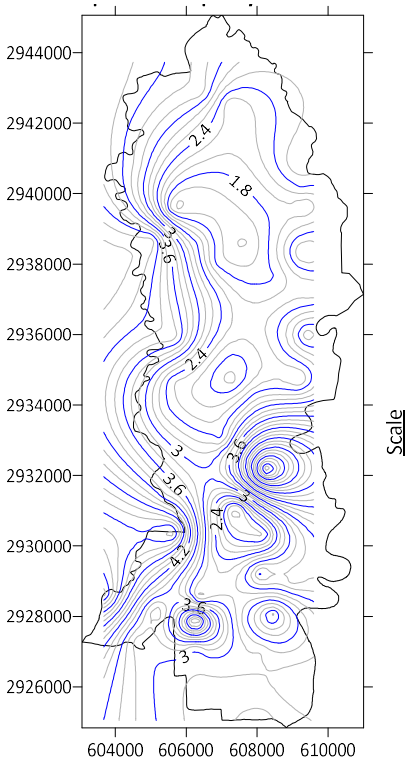
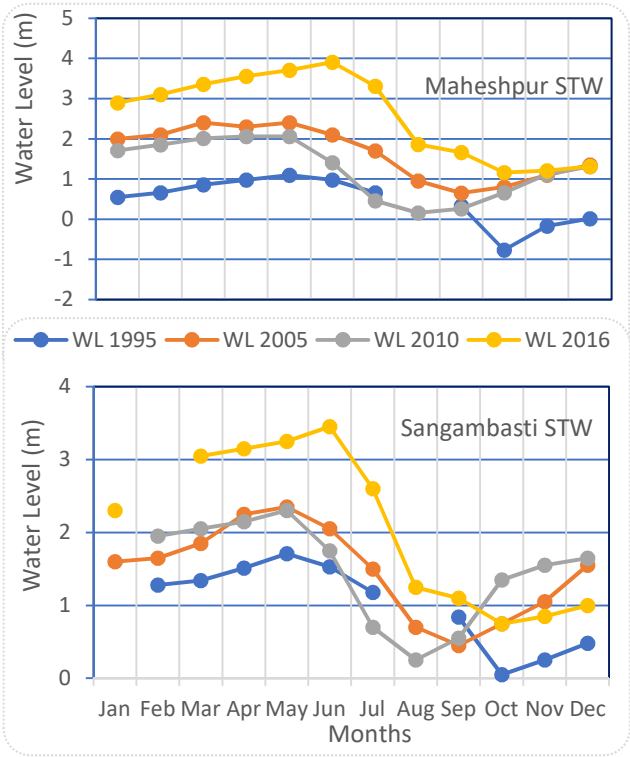
RESULTS

- The water table in the study area is found to be lowered by more than 3 m since 1995 to 2016.
- Current water level measured within 2 to 4 m bgl.
- Changing water level might change the engineering and geotechnical properties of the soil and consequently the site safety.





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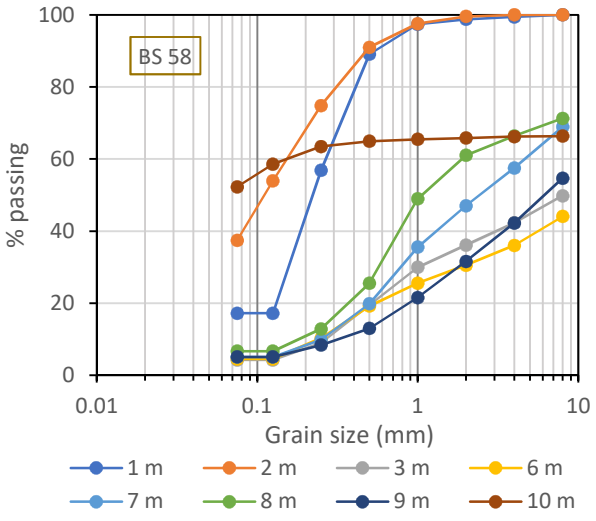
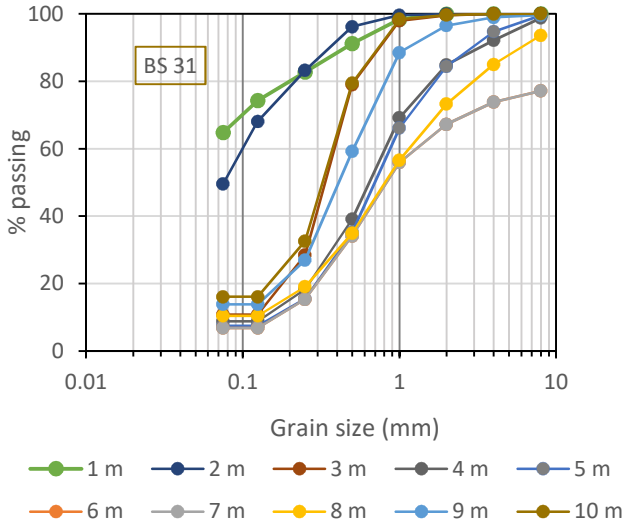
RESULTS

- Grain size distribution curve of the sediments shows clearly the two consistent soil types. However the % of fines relatively less that it exists only in very shallow depths where there is a top soils.





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RESULTS

S. N.	Bore Hole	Soil	Depths (m)	Water Level (m)	Miosture Content %	N-value blows (correc.)	Specific Gravity	Bulk density (Kg/m3)	UCS KN/m2	Direct shear Test				
										phi	c	KN/m 2	KN/m 2	KN/m 2
1	BS 29	Clay	0 - 1.45	3.5	31.3 -36.4	4	2.48 - 2.61	1850-2260	30.4	2.07-38.39	0.001 - 0.197	12.26-45.99	14.12-79.83	15.89-118.66
		Sand	2 - 8.45		14.9 -31	10 - 21								
2	BS 31	Clay	0 - 2.45	3.00	11.2 -22.5	4 -5	2.46 - 2.55	1840-2000	134.35	21.19-37.70	0.004 - 0.019	27.85-38.64	55.21-76.39	82.57-114.35
		Sand	3 -10.45		11.6 -20.5	12 - 36								
3	BS 53	Clay	0 - 1.45	3.51	33.1	4	2.56 - 2.63	1770-2370		26.9-51.0	0.003 - 0.198	39.81-65.70	69.33-126.51	94.24-188.58
		Sand	4 -8.45		4.2 -14.1	20 - 48								
4	BS 58	Clay	0 - 2.45	1.75	28.4 -36.2	2 - 4	2.61	2070-2130		35.9-41	0.039 - 0.123	39.42-55.11	74.92-98.16	12.45-141.22
		Sand	2 - 9.45		5.9 -12.5	12 - 23								

- Moisture content of clayey soil ranges from 11.2 to 36 % whereas the sands ranges from 12 to 31 %. Higher and lower values of moisture content is due to change in fine contents in the samples.
- The strengths of the material is changing with changing fine contents in the sample.

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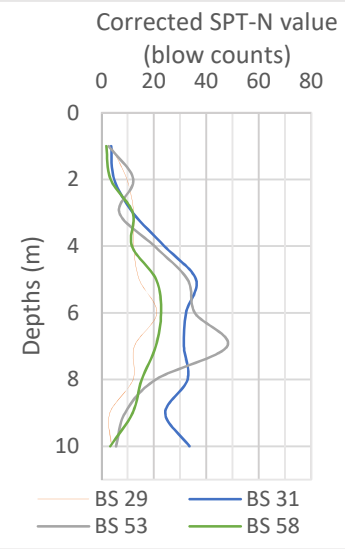
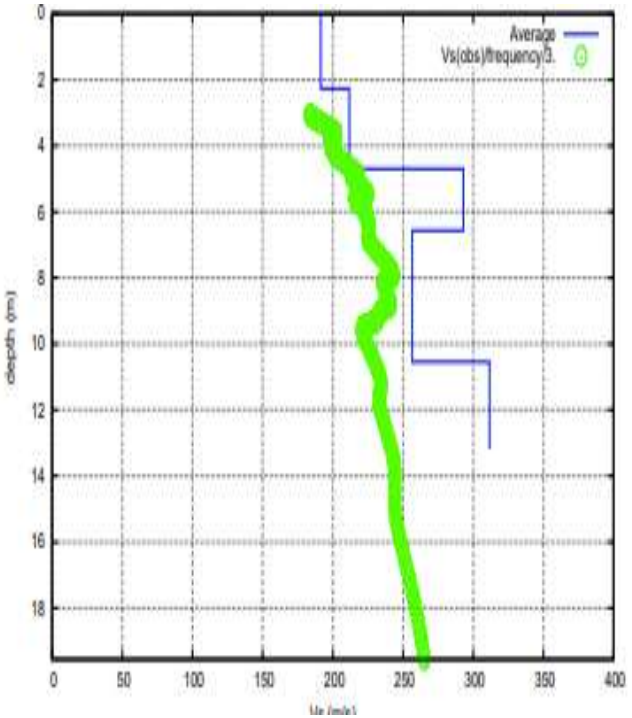
RESULTS

- Corrected SPT-N value of the soil shows higher blows starts at 4 m depth (>10 blows) and gets lower around 9 m in the curve displayed. SPT curve of BS 31 is correlated with the shear wave velocity model.





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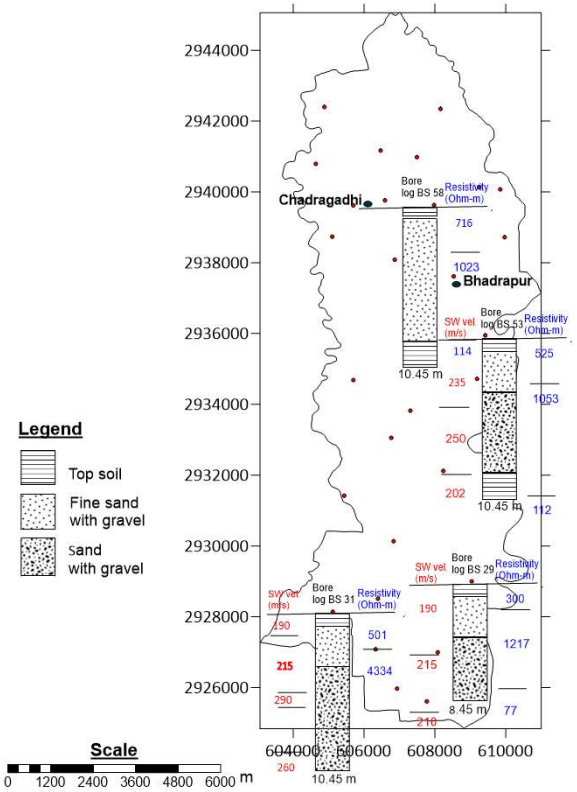
RESULTS

- Resistivity and shear wave velocity correlated with respect to the actual litho-log from north to south of the study area.
- Resistivity of fines (clay and silty clay) is less than 100 ohm-m whereas the coarse (sand and gravel) has resistivity > 1000 ohm m.
- The resistivity of the same material might vary depending on ion concentration of pore fluid. Contaminated water underneath largely change the resistivity of the sediments.
- In the same way the shear wave varies from 200 m/s to 325 m/s.
- Increasing stiffness of the soil increases the shear wave velocity at depths.



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CONCLUSIONS

- Groundwater level depletion since 1996 to 2016 is about 2 to 3 m. The likely change of geotechnical properties of shallow soils occurs. Current water table is at 2 to 3 m depth bgl.
- Gradation curve shows the investigated soil are prone to liquefaction where prominently the fine sands occurs.
- The area is mostly bounded by various river Mechi in east and Deuniya to the west. The litho-logs shows mostly predominant by coarse sediments (sand and gravel).
- In general, corrected SPT-N value is higher at a depth from 3 m.
- In the zone where there is high corrected SPT N value (>30 blow) there is a high resistivity ~1000 ohm-m and high shear wave velocity ~ >250 m/s.
- Data can be correlated with SPT N values with the resistivity and shear wave velocity.
- Using geophysical methods for site characterization might help in optimizing geotechnical parameters in the limited SPT data sets.

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CONCLUSIONS

Relevance to SnT conference:

The site characterization by various geophysical methods would be critical to the CTBTO on-site inspection team in order to understand the aftermath of nuclear explosion activities that could change the physical properties of the rocks and soils underneath with the surrounding less affected material. Hence the seismic and electrical methods would be vital for the site characterization.

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