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Estimation of Soil Grain Characteristic Using Cone Penetration Test for Rapti Main Canal

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ABSTRACT

This paper shows the Estimation of Grain Characteristic using the Cone Penetration Test (CPT) at a project under the Saryu Nahar Pariyojna in the basins of Rapti River named as Rapti Main Canal in Balrampur areas. This is the leading distributary project which have a stretch of 125 km through the Balrampur, Behraich and Shravasti districts of Uttar Pradesh. This area of Rapti Main Canal having a major concern about the soil Liquefaction due its soil behavior and water logging , here mostly we found silty sandy soil in saturated state. The objective of this paper is to evaluate Soil Index Behaviour in term of Ic using Cone Penetration Test given by the P.K. Robertson and C.E. (Fear) Wride in 1998 and updated work in Robertson 2009, CPT has become very popular because of its greater repeatability and the continuous nature of its profile.

KEYWORDS : Cone Penetration Test, Tip Resistance, Sleeve Resistance, Soil Behaviour Type Index.

Introduction

There are two equipment which are regularly use in soil investigation mainly one is Standard Penetration Test (SPT) and another is Cone Penetration Test (CPT)**.** There are one reason for the continuous use of SPT that to obtain the soil sample to determine the fines content of soil and its grain size distribution. However, this has been poor offset by the poor repeatability of SPT data. Hence with the increase interest in the Cone Penetration Test (CPT) due to his grater repeatability several research has developed to the soil investigation. From these research now it is possible to investigate the grain characteristics i.e. apparent fines content and grain size from CPT.

The primary advantage of CPT is that its gives continuous profile of penetration resistance and the results are generally more consistent and repeatable than results from other penetration test. The continuous profile also allow more detailed results of soil layers. To develop soil profile many of researcher is work on this i.e. Robertson and Camapanella (1985), Olsen and Malone (1988), Stark and Olsen (1995), Suzuki et al. (1995), Olsen and Koester (1995), Robertson and fear (1995), Robertson and Wride (1998). This paper shows the soil prolife of the Rapti Main Canal area in the Balrampur, this Rapti Main

Canal is constructed under the Saryu Nahar Pariyojna. It's having a stretch of 125 km and its capacity is about 95 cumec through Shravasti, Behraich and Balrampur districts of Uttar pradesh. Balrampur is situated on the bank of bank of Rapti River. Its shear his boundaries with Nepal for northern side, Gonda districts from south sides and Siddhartnagar from east-west side. In the north of Balrampur Districts is situated the Shivalik Hills of the Himalayas Mountains.

In recent year many of chart have been developed to estimate the soil type i.e. Olsen and Malone (1988), Olsen and Koester (1995), Robertson and Camapanella (1985), Robertson (1990), its shows that the CPT friction ratio (ratio of sleeve friction and tip resistance) is increase with increase in fines content and soil plasticity. Thus it is possible to estimate grain characteristic directly from Cone Penetration Test (CPT) data by using any of these Soil Behaviour chart. Robertson 1990 Soil Behaviour chart is shown in below Fig.1 in which area 1 show sensitive, fine content and area 2 shows peats, area 3 silty clay to clay, area 4 clayey silt to silty clay, area 5 silty sand to sandy silt, area 6 clean sand and silty sand, area 7 gravelly sand to dense sand, area 8

very stiff sand to clayey sand and area 9 is very stiff, fined grained.

Fig 1. Soil Behaviour Chart

Where, normalized friction ratio is defined as,

$$F = \frac{f_S}{q_C - \sigma_{Vo}} X\ 100\%$$

And Normalized Cone Resistance is

$$Q = \frac{q_C - \sigma_{Vo}}{\sigma'_{Vo}}$$

- $f_S = sleeve\ friction$
- $q_C = tip\ resistance$
- $\sigma_{Vo} = total\ vertical\ overburden\ stress$
- $\sigma'_{Vo} = effective\ vertical\ overburden\ stress$

The radius of each circle in this chart used as a soil behaviour type index, using the CPT chart by Robertson 1990 soil index behaviour index is defined as,

Boundaries of soil behaviour type are shown in the table below:

Soil Behaviour type Index, Ic	Soil behaviour type
Ic<1.31	Gravelly sand to dense sand
1.31 < Ic > 2.05	Sands : clean sand to silty sand
2.05 < Ic > 2.60	Sand mixture : silty sand to sandy silt
2.60 < Ic > 2.95	Silty mixtures : clayey silt to silt clay
2.95 < Ic > 3.06	Clays : silty clay to clay
Ic > 3.06	Organic soil : peats

And apparent fines content is defined as

$$FC(\%) = 1.75\, I_C^{3.25} - 3.7$$

$$If\ \ 1.26 \le I_c \le 35$$

This equation is slightly modification of original work by Robertson and Fear (1995) to increase the prediction of apparent FC for given value of I_c.

Study Area:

This **study** is on Rapti Main Canal which occurs under the Saryu Nahar Pariyojna. Rapti Main Canal having a stretch of 125 km long its capacity is about 95 cumec through Balrampur, Behraich and Shravasti districts of Uttar pradesh.

For the study we analyze the CPT data of nine village through which the canal is passes these areas are in the district of Tulsipur, Balrampur and in Shravasti. These areas are lies in the Shivalic range of Himalaya and near to the Rapti River. Water logging is the major problem in this area.

Geological Condition of the study area:

Balrampur lies on the bank of Rapti River it located at the 27.43°N latitude and 82.18°E longitude. It has an average elevation of 105 meter. Balrampur is situated on the bank of bank of Rapti River. Its shear his boundaries with Nepal for northern side, Gonda districts from south sides and Siddhartnagar from east-west side. In the north of Balrampur Districts is situated the Shivalik Hills of the Himalayas Mountains.

All the rivers of Balrampur District flow from north-west to south-east and belong to two main systems that of Rapti in the north and Ghaghara River in the south. Each is fed by numerous tributaries. The Rapti rises in the mountains of Nepal, and after traversing Bahraich District enters district Gonda. Its banks are usually high, but the river is continually changing its course. It only overflows its banks in wet seasons. On either side of Rapti River, but especially on the north, the country is cut up by innumerable deserted channels of the river. Many of these contain water for a part of the year only. But the only one which can be considered as a definite stream is that know as the Burhi Rapti which emerges near Mathura and flow across the district in a direction roughly parallel to that of the Rapti. Kuwana River flows with slow speed and Bishuhi River joins Kuwana. It covers very small part of the district.

Balrampur are in the Earthquake High Damage Risk Zone-IV. This zone is also called the high damage risk zone, IS code assign zone factor of **.24** for Zone-IV. This city located at the foothills of Himalayas and characterized under Zone IV, which is second highest seismic risk zone. Maximum land area of India about 59% are lies in risk Zone III, IV and V.

Assessment of Soil Index Behaviour:

Evaluation of soil behavior type index (), which is adopted from the suggested formula by Robertson and Wride 1998. Is given as follows;

$$I_c = \sqrt{(3.47 - logQ)^2 + (1.22 + logF)^2}$$

Where, Q is normalized tip resistance and F is normalized friction ratio, which is give as follows;

$$Q = \left(\frac{q_c - \sigma_{vo}}{\sigma'_{vo}}\right)$$

And, $$F = \left(\frac{f_s}{q_c - \sigma_{vo}}\right) \times 100\%$$

Where,

- $f_S = sleeve\ friction$
- $q_C = tip\ resistance$
- $\sigma_{Vo} = total\ vertical\ overburden\ stress$
- $\sigma'_{Vo} = effective\ vertical\ overburden\ stress$

The explanation boundaries of soil behaviour type at Rapti Main Canal area are described below with the help of graph between depth and index, I_c of different area, these graph are divided in 6 zone with the Soil Behavior Type Index, I_c these zone are as follows:

Zone 1	Gravelly sand to dense sand
Zone 2	Sands : clean sand to silty sand
Zone 3	Sand mixture : silty sand to sandy silt
Zone 4	Silty mixtures : clayey silt to silt clay
Zone 5	Clays : silty clay to clay
Zone 6	Organic soil : peats

1) AT BAHDINWA NALA, HARRAIYA ROAD, TULSIPUR Dist. BALRAMPUR

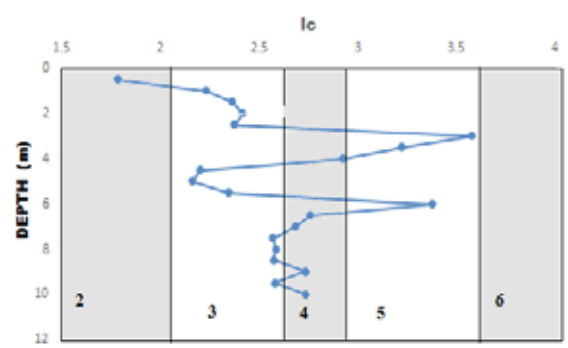

Fig.2: Index Behaviour at Bahdinwa Nala

2) AT GAURA MAFI, Dist. BALRAMPUR

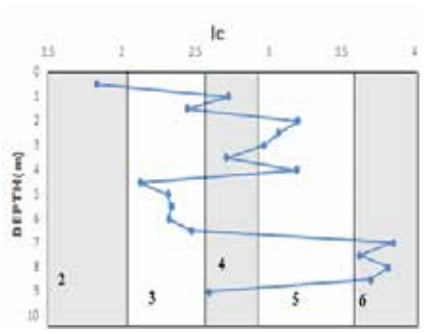

Fig.3: Index Behaviour at Gaura Mafi

3) AT VILLAGE GULWARIA, Dist. SHRAVASTI/BALRAMPUR

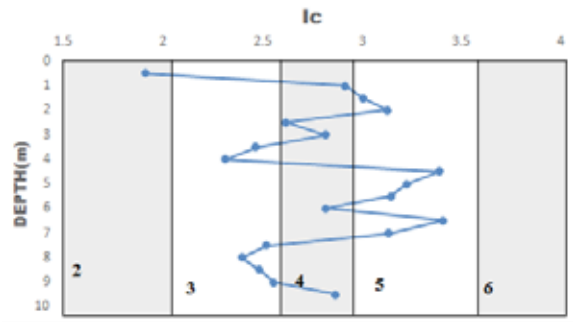

Fig.4: Index Behaviour at Gulwaria

4) AT VILLAGE TEDHI PRAS, Dist. SHRAVASTI/BALRAMPUR

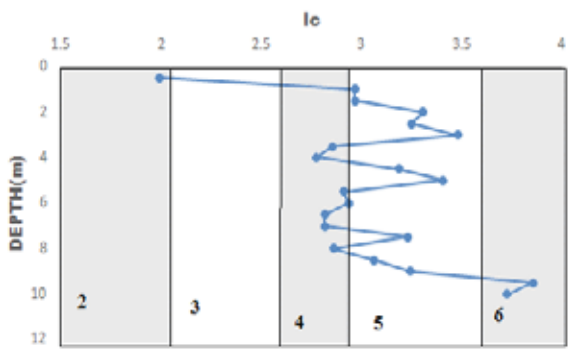

Fig.5: Index Behaviour at Tedhi Pras

5) AT VILLAGE LACHHAWAPUR, Dist. SHRAVASTI/BALRAMPUR

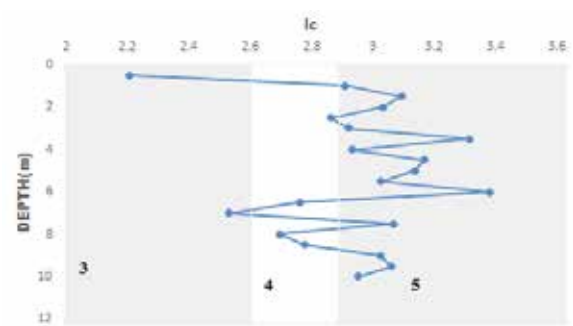

Fig.6: Index Behaviour at Lachhawapur

6) AT VILLAGE SIGRAURA, Dist. TULSIPUR/BALRAMPUR

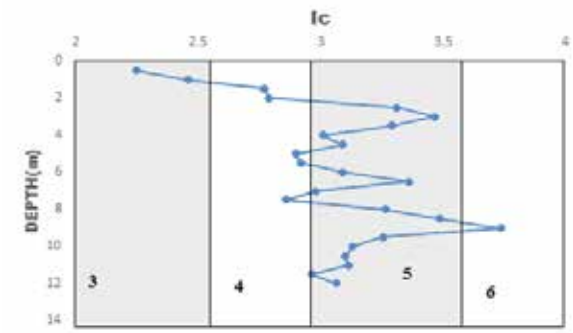

Fig.7: Index Behaviour at Sigraura

7) AT VILLAGE BHALUHIAN, Dist. BALRAMPUR

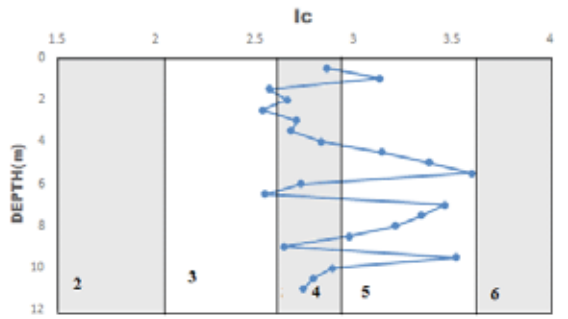

Fig.8: Index Behaviour at Bhaluhian

8) AT VILLAGE RAMWAPUR DEVNAGAR, Dist. TULSIPUR/ BALRAMPUR

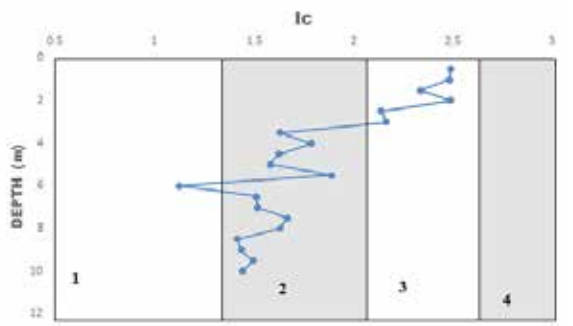

Fig.9: Index Behaviour at Ramwapur Devnagar

9) AT VILLAGE LALPUR, Dist. TULSIPUR/BALRAMPUR

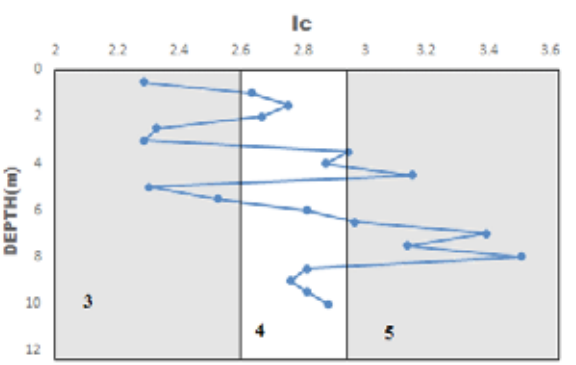

Fig.10: Index Behaviour at Lalpur

CONCLUSON:

Cone Penetration Test (CPT) give continuous data profile, by which easily determined the consistent and repeatable result in the examination of Soil profile. This continuous profile also allow us to study detailed result of soil profile

In above test result most of the soil profile occurs in zone 4 and 5 which shows that most of soil in depth 4 to 10 m are silty sand and silty clay.

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