Proceedings of IOE Graduate Conference, 2019-Winter
Peer Reviewed
Year: 2019 Month: December Volume: 7
ISSN: 2350-8914 (Online), 2350-8906 (Print)

Comparative Study on Geotechnical Properties of Bagmati and Trishuli River Sand with Ottawa Standard Sand

Sudhir Kumar Mishra [a], Indra Prasad Acharya [b]

[a, b] *Department of Civil Engineering, Pulchowk Campus, Institute of Engineering, Tribhuvan University, Nepal*
Corresponding Email: [a] sdhrmishra14@gmail.com, [b] indrapd@gmail.com

Abstract
This study focuses on comparative study on geotechnical properties of local sand with Ottawa standard sand. The total of two local sand Bagmati and Trishuli river sand from different location were collected. The samples were air dried and subjected to test in accordance with Indian standard code. The test carried out were grain size analysis, specific gravity, moisture content, void ratio, constant head permeability test and direct shear test at relative densities 25%, 50% and 75%. The properties of samples were compared with a Ottawa standard sand in order to find out which of the two sands serve as standard baseline sand. The result shows that Bagmati and Trishuli river sand is poorly graded, more permeable, higher void ratio and lower shear strength while Ottawa standard sand is uniformly graded, heavier, less permeable and higher shear strength. It was therefore concluded that Bagmati and Trishuli river sand could not be used as standard baseline sand for research and construction work, like the Ottawa sand.

Keywords
Bagmati River sand – Trishuli River sand – geotechnical properties – Laboratory experimental sand – Ottawa sand

1. Introduction

In Nepal, Sand is used as aggregates in the construction industry, test samples in geotechnical and soil science laboratories, experimental porous medium in hydrologic studies and for other uses. The use of sand for construction purposes play significantly role. Limited studied has been done regarding standardizing the properties of sands. Sands deposited at different places would be expected to have different angularity, mineralogy and gradation. As per different researchers [1, 2], assessment of geotechnical properties of subsoil at project site is necessary for generating relevant input data for design and construction of foundations for the proposed structures. Ottawa sand is standard sand used in civil structures like, building, bridges, dam, towers etc. so comparative study of Trishuli, Bagmati river sand with Ottawa standard sand is necessary for use. In fact,shape,gradation and mineralogical characteristics of sand affect the mechanical and engineering properties of soil. Engineering behavior of sand has not been as exhaustively investigated as that of clays, probably because sand was rarely considered as troublesome material. But, it is well recognized now that the behavior of sand can pose lot of trouble to structures built on (foundations to buildings, bridges), built in (tunnels, culverts, basements), built with (roads, runways, embankments, dams) it especially when it is in a very loose to loose state and also when it loses its confinement even if it is in a dense state.

2. Research Objectives

This research considers a laboratory analysis and comparative study of the

1. Index properties of sample Trishuli and Bagamti river sand with medium Ottawa sands.
2. Permeability and shear strength characteristics of Trishuli and Bagmati river sand with Ottawa sand.
3. Variation of shearing resistance of sand at different strain rate at a particular normal stress. This research will assess the different geotechnical properties of three sands in order to ascertain which of the sands can be used as a standard for construction and experimental purposes.

This study focuses on different laboratory tests compared for geotechnical properties at relative density 25%, 50% and 75%.

3. Literature Review

Soil has unique and distinct engineering properties. Sand deposited at different places to have different properties depending on location, mineral grains etc. The properties of soil which are not primary interest of geotechnical engineer but which are indicative of the engineering properties are called index properties. Empirical relationships between the properties of soil are generally sought for preliminary design and planning of quality control program to be implemented in the construction site. Geotechnical properties gives an idea about suitability of the soil as a construction material, its determination is helpful in compaction of coarse grained soils and in evaluating safe bearing capacity of sandy soils, which have direct effect on the safety of hydraulic structures, shearing strength. Large number of studies were done by the previous researchers to find out different geotechnical properties of soils.

The particle size distribution curve (gradation curve) represents the distribution of particles of different sizes in the soil mass [3]. Based on the study, Roy and Dass [1] found that increase in specific gravity can increase the shear strength parameters (cohesion and angle of shearing resistance). Density index measure of the degree of compactness, and the stability of a stratum [4]. The permeability of soils has a decisive effect on the stability of foundations, seepage loss through embankments of reservoirs, drainage of subgrades, excavation of open cuts in water bearing sand and rate of flow of water into wells It is explained that the capability of a soil to support a loading from a structure, or to support its overburden, or to sustain a slope in equilibrium is governed by its shear strength. The shear strength parameters of a granular soil are directly correlated to the maximum particle size, the coefficient of uniformity, the density,the applied normal stress, and the gravel and fines content of the sample. Soil containing particles with high angularity tend to resist displacement and hence possess higher shearing strength compared to those with less angular particles [5]. Ottawa sand is standard sand used in civil structures like building, bridges, dam, towers, tunnel, hydro structure etc.

4. Materials and Methods

A conceptual framework on comparative studies was developed through several studies are carried out in the past by many researchers [6, 7].

4.1 Location

The soil used in this study was Trishuli river sand at Galchi Trishuli, Bagmati river sand at Karmahiya; Rautaht Sarlahi boarder on Mahendra highway and the standard medium Ottawa sand was obtained from market i.e. commercially available Ottawa sand is medium type sand. so, medium type Ottawa sand was choosen for this research.

4.2 Sampling

The tools used for the collection of samples for the purpose of this study were shovel, hand auger, sample bag and measuring tape. The soil samples were collected using shovel and kept in sample bags. Auger was also used to collect the sand samples and measuring tape was used to measure the depth. The two samples Bagmati and Trishuli were taken from 200mm below sample point and third sample Ottawa sand was used.

The properties of Bagamati and Trishuli river sand is Medium Grayish color, grains are angular and flaky with few rounded and poorly graded while Ottawa standard sand have colorless, rounded and angular grains and uniformly graded.

4.3 Laboratory analysis procedures

The laboratory tests that were carried out on these soil samples include geotechnical properties of sands. Tests were carried out in the following laboratories, Central Material Testing Laboratory, Pulchowk and Heavy lab Pulchowk Engineering Campus. All the soil Geotechnical properties tests were conducted according to the procedures as per IS codes as follows;

1. The Grain size distribution was determined using set of sieve and sieves were shaken for 10 minutes in mechanical shaker and mass so retained were weighted (IS 1498-1970).
2. The Specific Gravity of sand was determined using Pycnometer (IS: 2720 part 3).
3. Maximum void ratio was determined by pouring the cohesion less sample via funnel in

spiral motion outside to the centre.The funnel height of free fall was maintained always 25mm during the sand fall. The diameter and height of mould used is 15.24 cm and 15.5 cm respectively and The minimum void ratio was determined by oven dried sample was placed in the mould (D : 15.24 cm, H: 15.5 cm) and fixed on vibrating table to vibrate for 8 minute loaded with surcharge of 8 kg (IS 2720-part XIV).

4. The required mass was calculated to achieve the relative density at 25%, 50% and 75% and Constant head Permeability Test was done as per (IS: 2720 (Part XVII) 1986.
5. The required mass was calculated to achieve the relative density at 25%, 50% and 75% Direct shear test (IS 2720 part 13-1986).

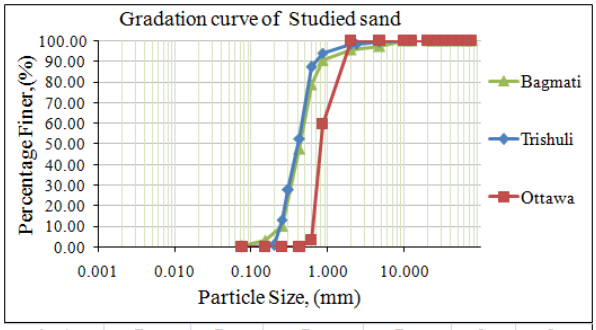
Three tests were performed for each of the sand to get an average value of all tests. All data from Laboratory test are collected analysed and compare with Ottawa standard sand by graphical methods.
When the test was done due consideration was taken care of and minimum fault due to instrument and environment were also taken into consideration.

5. Results and Discussions

Comparative study of geotechnical properties of each sand sample and standardized Ottawa sand was made. Appropriate graphical methods were employed to obtain some relationships between properties of Local sands and standard Ottawa sand.

5.1 Grain size distribution

From Figure 1, it can be observed that Bagmati and Trisuli river sand is poorly graded while Ottawa sand is uniformly graded. It is clear from Figure 1, that the grain size distribution of Bagmati and Trishuli river sand is very closely to each other but Ottawa sand is better in quality in terms grain size than other two studied sand.



Sand	D_{60}	D_{50}	D_{30}	D_{10}	C_u	C_c
Bagmati River	0.50	0.42	0.33	0.22	0.99	2.27
Trishuli river	0.46	0.40	0.32	0.24	0.93	1.92
Ottawa	0.84	0.80	0.71	0.60	1.00	1.40

Figure 1: Gradation curve of Bagmati, Trisuli River and Ottawa Standard Sand

5.2 Specific gravity

From Figure 2 and Table 1 comparison were made in percentage in respect of Ottawa standard sand as 100%.The percentage difference for Bagmati and Trishuli river sand is 1.88% and 1.5% respectively. Table 1 indicates the Ottawa sand is heavier than Bagmati and Trishuli River sand.

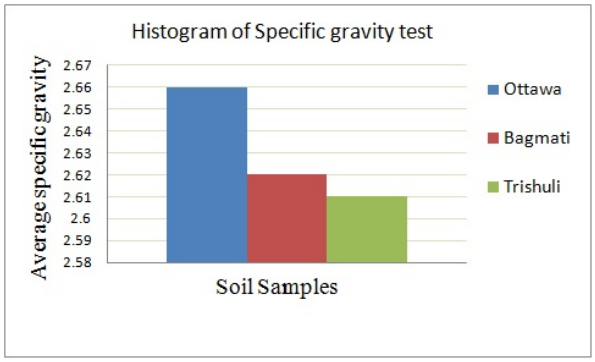


Figure 2: Histogram of Average specific gravity test of the studied sands

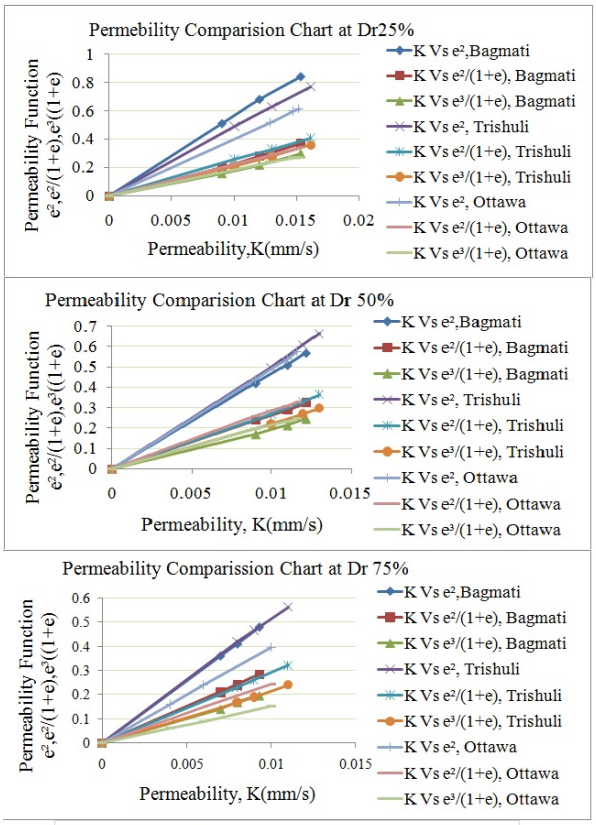
Table 1: The Result of average specific gravity tests of the studied sands

Sand	Sp Gravity
Ottawa	2.66
Bagmati River	2.62
Trishuli river	2.61

From Table 1 and Figure 2, indicates the Ottawa sand is heavier than Bagmati and Trishuli River sand.

5.3 Permeability

From Figure 3 The relationship between permeability and permeability function shows that Trishuli and Bagmati river sand is more permeable than Ottawa standard sand since the permeability factor of Bagmati and Trishuli river sand is higher than Ottawa sand, . The water holding capacity of Ottawa sand is more than Trishuli and Bagmati river sand.
It is seen that both the sand follows Kozeny-Carmen equation as they follows linear relationship with permeability function.



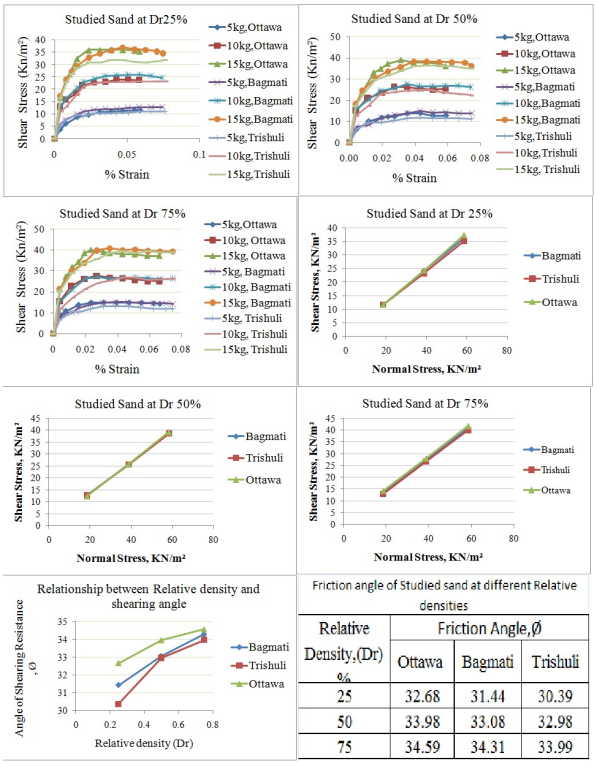
Result of Permeability and Void ratio of the studied sands

Sand	D_r	k	enat	e^2	$e^2/(1+e)$	$e^3/(1+e)$
Ottawa	25%	0.015	0.785	0.616	0.345	0.271
	50%	0.012	0.76	0.578	0.328	0.249
	75%	0.01	0.63	0.397	0.243	0.153
Bagmati	25%	0.0153	0.818	0.668	0.368	0.301
	50%	0.0122	0.755	0.570	0.325	0.245
	75%	0.0093	0.6925	0.480	0.283	0.196
Trishuli	25%	0.016	0.878	0.770	0.410	0.360
	50%	0.013	0.815	0.664	0.366	0.298
	75%	0.011	0.75	0.563	0.321	0.241

Figure 3: Comparison of K against permeability functions of studied sands at relative density25%, 50% and 75%.

5.4 Direct shear test result

From Figure 4 shows that value of shear strength is higher for Ottawa standard sand than Bagmati and Trishuli river sand. The Bagmati river sand is coarser than Trishuli river sand. so,the shearing resistance of Bagmati river sand is higher than Trishuli river sand. From laboratory test result analysis of sands,the shear strength is lowest for loose condition while highest in case of dense condition for all three studied sand.



Friction angle of Studied sand at different Relative densities

Relative Density,(Dr) %	Friction Angle,Ø		
	Ottawa	Bagmati	Trishuli
25	32.68	31.44	30.39
50	33.98	33.08	32.98
75	34.59	34.31	33.99

Figure 4: Comparison of Stress-Strain curve and shear stress Vs Normal stress curve of Local sands with Ottawa standard sand at relative density 25%, 50% and 75% and Relative density Vs Angle of shearing resistance of studied sands.

6. Conclusions

1. The grain size distribution of Bagmati and Trishuli river sand is close to each other but Ottawa sand is better in quality in terms grain size than other two studied sand. Bagmati sand and Trisuli river sand is poorly graded while Ottawa sand is uniformly graded.

2. Ottawa standard sand is heavier than Bagmati and Trishuli river sand.

3. Trishuli river and Bagmati river sand is more permeable than Ottawa standard sand. Since the coefficient of curvature and coefficient of uniformity of Ottawa sand is higher in comparision to Trishuli and Bagmati river sand, so, the water holding capacity of Ottawa sand is higher than Trishuli and Bagmati river sand.

4. The higher value of friction angle of Ottawa sand is due to its coarser size and shape of particles in comparison to other studied sands. The result shows that Bagmati and Trishuli river sand is poorly graded, more permeable, higher void ratio and lower shearing strength while Ottawa standard sand is uniformly graded, heavier, less permeable and higher shear strength. It was therefore concluded that Bagmati and Trishuli rivers sand could not be used as standard baseline sand for research work, like the Ottawa sand.

References

[1] Surendra Roy and Gurcharan Dass. Statistical models for the prediction of shear strength parameters at sirsa, india. *International Journal of Civil and Structural Engineering*, 4(4):483, 2014.

[2] H O Nwankwoala and T Warmate. Geo-technical Assessment of Foundation Conditions of a Site in Ubima, Ikwerre Local Government Area, Rivers State, Nigeria. page 15.

[3] Stephen J Mallo and Ikani N Akuboh. Geotechnical Investigation of Soils: A Case Study of Gombe Town (Sheet 152nw), North Eastern Nigeria. page 7, 2012.

[4] S Prakash. Engineering soil testing, nemchand & bros. *Publications*, 2002.

[5] Gopal Ranjan and ASR Rao. *Basic and applied soil mechanics*. New Age International, 2007.

[6] Oluwapelumi O Ojuri and David O Fijabi. Standard sand for geotechnical engineering and geoenvironmental research in nigeria: Igbokoda sand. *Adv. Environ. Res*, 1(4):305–321, 2012.

[7] Misko Cubrinovski and Kenji Ishihara. Maximum and minimum void ratio characteristics of sands. *Soils and foundations*, 42(6):65–78, 2002.