Proceedings of the 6th International Conference on Civil Engineering for Sustainable Development (ICCESD 2022), 10~12 February 2022, KUET, Khulna, Bangladesh (ISBN-978-984-35-1972-6)

FIELD STUDY OF LAND DEVELOPMENT AT NEW ACQUISITION LAND SITE IN KUET

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ABSTRACT

This paper is concerned with the study where the use of sand to fill-up the low land of new acquisition land 16.352 acres of KUET under the project of "Expansion of Infrastructure and Academic Activities of Khulna University of Engineering and Technology (KUET)." New acquisition land has been developed for enhancing the infrastructure of this university. There are one 10 storied Academic Building, 30000sqm floor area, one 10 storied Institute Building, 20000 sqm floor area and, 10 storied new student hall (male), 22500 sqm, lake and internal road way will be constructed in this land. The extended area of acquisition land was a low land used as fish cultivation pond. The average Reduced Level (RL) of new acquisition land was 0.305m where the maximum height of RL is 3.10m is measured at the front of main gate of KUET and the average level height of KUET is 2.717m (RL) in front of Planning and Engineering Building at the middle position of KUET. The filling height of new acquisition land is 2.412m. Total land area were filled by river sand name as local sand of Fines Modulus (FM) of 0.6 to .0.8 is used by the process of local method of water jetting with pipe network. There are local material bamboo, dram shit and geo-bags are used for site protection of outside of the new acquisition land and the side of lake. There are 10 ton capacity of roller machine is used for high compacting in road area of this land and others area are compacted in natural process of water jetting. There are 12nos of settlement plate are installed in the natural ground and the road space for measured the settlement value at future. The field compaction are measured at the natural ground and road location and there values are more than 95%. The method of sand filling at this site is economical and reliable method that reduced transportation cost and wastage hazard of KUET. Field investigation revels that the land development use of local sand and available materials and the technique can be used successfully as a suitable method to develop the low land for use space and construction of the infrastructures.

Keywords: *Land development, sand,* geo-bags, *compaction,* fineness modulus.

1. INTRODUCTION

Fill sand is a common material used in both residential and commercial construction projects. It is an obvious truism that structures should be constructed on good quality ground. Ground conditions of construction sites, however, have become worse in recent decades throughout the world. This situation is especially pronounced in Bangladesh, where many construction projects are conducted on soft alluvial clay grounds, reclaimed grounds with dredged soils, highly organic soil grounds, and loose sandy grounds and so on. When any types of infrastructures are constructed on these types of soil large amounts of ground settlement and/or stability failure are likely to be encountered. Apart from clay or highly organic soil

grounds, loose sand deposits under a water table cause serious problems of liquefaction under seismic conditions.

Soft fine-grained soil with significant organic content dominates the sub-soil of Khulna in Bangladesh, which often creates problem to the geotechnical engineering to select suitable economic foundations for structures due to low share strength and high compressibility (Alamgir et. al 2001). On the other hand Bangladesh is the land of Rivers country. In Bangladesh maximum low land are filled for the construction of the infrastructure where maximum cases use of the river sand name as local sand. There are few methods as filling process as well as one is carrying of transport and another is water jetting with pipe network and etc. Land filling with fine sand through water jetting is the state-of-the-art method in Bangladesh. In Bangladesh there are every corner of the country having rivers and their tributaries so the river sand is got very easy way.

This study has been undertaken to depict the applicability of the method of land filling site of KUET. There are 16.352 acre land is acquired under the project of the "Expansion of Infrastructure and Academic Activities of Khulna University of Engineering and Technology (KUET). Where one 10 storied Academic Building, one 10 storied Institute Building and, 10 storied new student hall (male), lake and internal heavy loaded road way will be constructed. There are new acquisition land of KUET are developed by local sand, Fineness Modulus (FM) of 0.6 to 0.8. The new acquisition land was fish cultivate land and land level was below about 2.717m from existing ground level of KUET. There are local material bamboo, dram shit and geo-bags are used for site protection of sand filling at outside of the new acquisition land and the side of lake. Sand is carried to KUET through water jet pumping system from barge in river. The filling height of new acquisition land is 2.417m. in normal ground and road space. There are 0.3m depth of soil layer placed on filling sand in natural ground. This study is shown that sand transportation of this method is the cheapest way for carrying and time saving. The other specific big advantages that this method is environmentally highly eco-friendly.

2. LAND FILLING OF THE STUDY SITE

The filling site is new acquisition land of KUET that is filling by local materials and methods are described in the following sections. Locally available filling material, local sand, site protection material, bamboo, dram sheet, geo-bags and its filling methods are employed.

2.1 Location of the Study Site

The investigation site is located at the west side of KUET campus. The KUET campus is situated 12 km. from Khulna city center i.e. south-west part of Bangladesh. and to the 1 km. west of Khulna-Jessore highway. The campus map of KUET, location of the land development site at the campus map and the map of Bangladesh is shown in the Fig. 1.

2.2 Sub Soil Conditions

The general sub-soil condition in the south-western part is similar to that of KUET campus. Standard penetration test associated with related field and laboratory tests was conducted to characterize the sub-soil conditions up to 60m depth from the existing ground surface as presented at Table 1. The sub-soil at the top 0 to 5 ft consists of a layer of soft clay, after that a thin layer of clay exists which is followed by a thick organic clay layer of soft consistency at a depth of 5 to 15 ft. Beyond this layer, the sub-soil is encountered as silty clay of soft consistency till the final depth of boring. The field test shows that the N-value remains almost uniform at a range of 4 to 5 throughout 80 ft depth. After that 90 to 200 ft layer of fine sand revealed. Alamgir and Zaher (2001) reveals almost similar sub soil profile in another location about 500m apart at

Figure 1: Location of the land development Site.

Table 1: Geotechnical engineering properties of the site at new acquired land in KUET campus.

Physical and Engineering Properties of Soil												
Depth (ft)	**Type of soil & color**	N_f	γ (Kn/m^3)	G_S	e_0	c_c	c_s	q_u (kPa)	w	w_L	w_p	F_{200}
0-5	Mostly clay trace silt Gray	2	19.0					58.4	235	113	59	
5-10	Organic clay Black	2	17.1	2.46	1.33	0.58	0.08	41	131			
10-15		2						112	109			
15-20	Mostly clay some silt Gray	5	17.0						35	52	31	
20-25	Mostly clay some silt Gray	5							36			
25-30		4						85.2	45			
30-35		4							45			
35-40		5							47	47	33	
40-45		4							50			
45-50		4							46			
50-60		4							42			
60-70		4							50			
70-80		5							39			
80-90	Mostly fine sand trace silt trace clay Gray	17							23			20
90-100		34							75			
100-110		41										
110-120		30							19			
120-130	Mostly clay trace silt trace sand Gray	20							25	48	19	
130-140	Mostly fine sand trace silt trace clay Brown	52							29			28
140-150		47										
150-160		75										
160-170		110										
170-180		110										
180-190		60										5
190-200		70										

Note: N_f = field SPT number, γ = unit weight, G_S = specific gravity, e_0 = natural void ratio, c_c = compression index, c_s= swelling index, q_u = unconfined compression strength, w = water content in percentage, w_L = liquid limit, w_p=plastic limit, F_{200} = percent finer passing #200 sieve.

KUET campus, where field investigations were conducted to established the performance of stone columns and sand compaction piles as installed using both the dry-displacement (Zaher 2000) and wet-replacement methods. Table 1. shows the typical Geotechnical engineering properties of the site at new acquired land in KUET campus.

2.3 Filling Materials of the Site

The filling material of this site is local fine sand, which are collected either from the river itself or its flood plain and accounts for the majority of the sand used in the construction industry. The rate of sand mining in such areas greatly outweighs the rate the sand can replenish, making it a non-renewable resource (Padmalal & Maya, 2014). Filling sand as well as local sand of Fineness Modulus (F.M.) is measured of 0.56 which is used to fill the new acquisition land of KUET. Fig. 2 shows the Grain Size distribution of filling sand of the land development site.

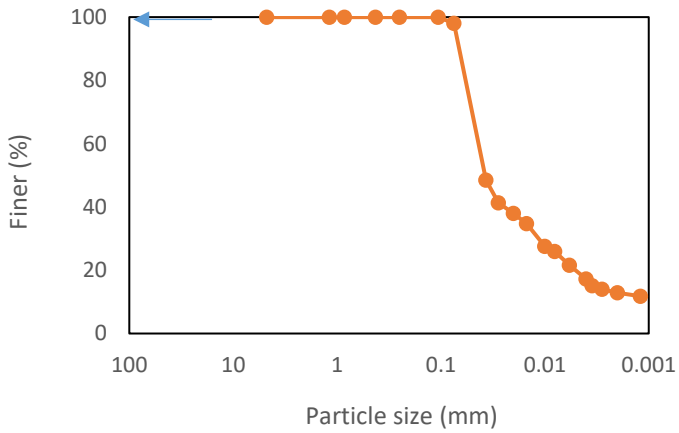


Figure 2: Grain size curve by Sieve analysis & Hydrometer test.

2.4 Filling Method of the Land Development Site

At first the boundary lines of new acquisition land of 16.352 acre which is filled of sand is finalized by the surveyors of DC office of Khulna. After that presurvey of contour of the land is measured by use of Real Time Kinematic Global Positioning System (RTKGPS) method. The height RL is 3.10m is measured at the front of main gate of KUET and the average value of 2.717m RL is at the middle position of KUET. The lowest RL is -1.55m at the cannel of north-west corner of new acquisition land of KUET. The extended area as well as filling area was low land which was used as fish cultivation land. In spite of water-logged site, at the beginning water is removed from low land of new acquisition land by pumping system and after that existing tree is cutdown and root of the trees are removed from the ground as like uprooted properly as shown in Fig. 3. There are few steps of the land development site are bellows:

Figure 3: Existing tree is cutdown and root of the trees are removed from the land development site.

2.4.1 Site Protection of Filling Site

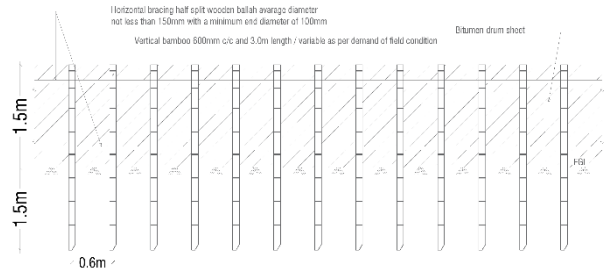
The maximum location of the study site was a low-lying water-logged area. At first dewatered the land properly then cut down existing all tree as like uprooted. There are two types of method are used for site protection for sand filling. One is used for protection for filling sand at the boundary land in the new acquisition land and another is used for create the lake in the new acquisition land.

2.4.1.1 Outer site shore protection of land development site

North and west site of new acquisition land is low area of fish cultivate land and three educational institute, TT College, Govt. Laboratory school and TTC are situated at south side of this site. North and west side are protected by use of locally produced bamboo, diameter of 100mm and bituminous dram shit is used as land filling protection in the site. The local bamboo is light with good flexibility and high toughness. About 3m length of bamboo is used and 1.5m length of bamboo is inserted in the clay for stability. The half split wooden bullae average diameter not less than 150mm with a minimum end diameter of 100mm are used for horizontal bracing. Figure 4 shows the shore protection of bamboo pile with dram sheet at the land development site. The tensile and compressive strength of bamboo along grain direction are 170MPa and 80MPa respectively (Zheng et al, 2020). The local bamboo grows fast and yields high. Bamboo is green and environmentally friendly, it is widely used in construction materials (Zheng et al, 2020). Table 2. Shows the physical and mechanical properties for bamboo material (Zheng et al, 2020). Figure 5,a) shows the pressure diagram shit pile wall penetrating clay (Braja M. Das et al 2017). The bamboo pile and dram shited wall acts as near of sheet pile. There pressure diagram of shore protection in land development site are measured as shown in Fig. 5, b.

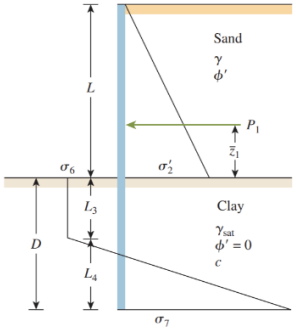
Table 2: Physical and mechanical properties for bamboo material (Zheng et al, 2020).

Density ($kN/m^{3)}$	Tensile Strength (Mpa)	Compressive Strength (Mpa)	Shear Strength (Mpa)	Flexural Strength (Mpa)	Allowable Tensile Strength (Mpa)	Allowable Compressive Strength (Mpa)	Allowable Shear Strength (Mpa)	Elastic Modulus (Gpa)	Flexural Modulus (Gpa)
7.32	124	55.1	66	116	27.6	27.6	14.8	12	70

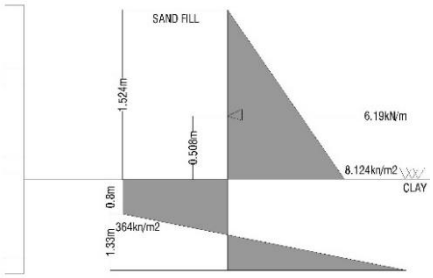


(a) (b)

Figure 4: Shore protection of bamboo pile with dram sheet at filling site. a) Schematic sectional elevation of palisading Work. b) Shore protection outer side in land development site.



P_1-load per unit length,
D-Maximum moment, L-length



(a) (b)

Figure 5: Pressure Diagram of Bamboo pile supported wall. (a). Shit pile wall penetrating clay (Braja M. Das et al. 2017), (b). Pressure Diagram of shore protection in land development site

2.4.1.2 Side protection of lake shore in the land development site

Geobags have been used in river protection structures for more than a decade. Given the variations in bag size used in the experiment, tolerance limits in their initial placement and ignorance of the bag permeability and its state of wetness, the hypothesis was that the initial response of any layer of geo bags in the DEM model would indicate the critical location for bag instability in the revetment (Yang et al. 2006). There are 3.23mm thickness of geotextile (under 2 kPa pressure) and effective opening size EOS<0.075mm are used to make geo bag size of 850mmx 475mm. Test result of geotextiles are shown in Table 3. About 80 kg of local sand is filled in the geobag. There are 6 layers of geo bags are placed at the angle of 35 to 45 degree at side of lake. Figure 6 shows the schematic drawing of geo bag protection at the side of lake in land development site. After placement of the geo bags 300mm layer of soil are placed on the angle of geo bags and filling sand that is shown in Fig. 7. There are 0.30m of soil layer are placed on the protection of geo bags.

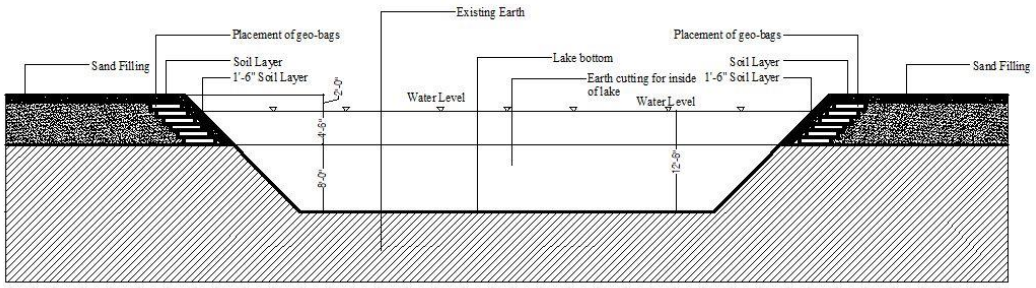


Figure 6: Schematic drawing of geo bag protection at the side of lake in land development site.

Table 3: Test result of geotextiles. (CRTS, Civil, 2021)

SL No	Parameter	Test Standard.	Unit	Test Result
1	Mass per unit area	ASTM D 5261	gm/m²	452
2	Thickness (under 2 kPa pressure)	ASTM D 5199	mm	3.23
3	Effective Opening Size (EOS)*	ASTM D 4751	mm	EOS<0.075

Figure 7: Side protection of lake by use of geo bag in land development site.

2.4.2 Transportation Process of Sand

Sand is transported through river vessels name as cargo. Sand is collected from the river itself or its flood plain. The majority of the sand are collected at the cables ghat point. There are 200mm diameter and 4270m length of PVC pipe are placed for pipe line network. The pipe line consists of a suction cap to collect the wet sand and there are a booster motor situated at the approximate middle pipe network in Jabdipur, Fulbarigate for transported the sand to land development the booster machine is linked between sand unloading points of the river to KUET land development site. Booster machine consists of a heavy 300 Horse Power (HP) engine which can carry 10,000cft of wet sand within 1hour. Figure 8 shows the transportation process of sand.

2.4.3 Sand Filling of Land & Road Location in the Land Development Site

The new acquired land is filled with fine sand carrying through pipeline and a system was developed to carry the sand from river unload side to the land development site. A dewater was required continuous to dry the sand in study site. The network of heavy road ways is planned in study site. A network of pipeline

was used to transporting sand. In road ways extra compaction has applied. There are 10ton capacity of roller machine is used for high compacting in road area of this land site and others area are compacted in natural process of water jetting. There are 0.30m of soil layer are placed on the sand layer of normal ground space. Figure 9 shows the schematic diagram of sand compaction in natural ground and proposed road site.

(a) (b) (c)

Figure 8: Sand Transportation Process. (a) Sand unloading site. (b) Booster machine. (c) Sand filling Site

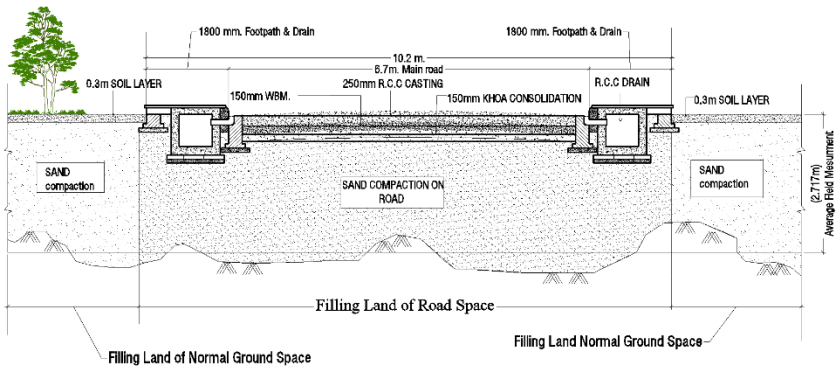


Figure 9: Schematic diagram of sand compaction in natural Ground and proposed road site.

2.5 Installation of Settlement Plates in the Land Development Site

Settlement plates are commonly installed where significant settlement is predicted (John Dunnicliff et al.1988) to record the magnitude and rate of settlement under a load. Therefore, they should be placed immediately after installing the vertical drains. In the simplest form, this instrument is a settlement plate consisting of a steel plate placed 600mmx600mm and thickness 20mm on the ground before construction of the embankment. Surface settlement points measure vertical displacement with depth, for example, along an embankment centerline.

Manal Salem et. al. suggested a reference rod of 25mm diameter and protecting pipe 38mm diameter water grade pipe are attached to the settlement-monitoring platform (Manal Salem et al 2013). Settlement is often evaluated periodically until the surcharge embankment is completed, then at a reduced frequency, measuring the elevation of the top of the reference rod. Benchmarks used for reference data must be stable and remote from all other possible vertical movements. There are 8 nos of settlement plate (SP) are placed in the natural ground and 4 nos of settlement plate there length of 3.0m are placed in the road space for measured the settlement value which is shown in Fig.11.

(a) (b)

Figure 11: Installation of Settlement Plate in Filling Site. (a) Location of settlement plate in the land development site (b) Installation of Settlement Plate in land development site

3. STUDY RESULTS OF THE LAND DEVELOPMENT SITE

Table 4: Field compaction test results

Test Point No.	Test Point Location	Field Density Test Sand-Cone Method (ASTM D 1556)		Laboratory Compaction Test Standard Proctor Method (ASTM D 698)		Relative Field Compaction
		Dry Density	Moisture Content	Maximum Dry Density	Optimum Moisture Content	
		(gm/cc)	(%)	(gm/cc)	(%)	(%)
1	TP1	1.53	27.6			94
2	TP2	1.54	23.6			95
3	TP3	1.52	29.7	1.63	17.0	93
4	TP4	1.48	33.5			91
5	TP5	1.52	29.3			93
6	TP6	1.52	18.0			96
7	TP7	1.49	19.7			93
8	TP8	1.42	35.7	1.60	19.0	89
9	TP9	1.46	26.7			91

Local material, bamboo, bituminous drum shite, geo bags are used for site protection of sand fill and the method of two types, one is used for protection for filling sand at the outer boundary land in the new acquisition land and other is used for create lake in the new acquisition land which are acted as stable. Total land of 16.352 acre and depth of 2.417m was filled by river sand name as local sand of Fines Modulus (FM) of 0.6 to 0.8 is used by the process of local method of water jetting with pipe network. The time of 4 months (120days) was required to fill up the land of filling sand. There are 0.3m depth of soil layer are placed on

filling sand in natural ground. The method of sand filling at this site is economical and reliable method that reduced transportation cost and wastage hazard of KUET. There are 9 nos sand compaction tests are conducted in dry condition of the land development site where few tests are on the filling land of road space and few tests on the filling land of normal ground. It is depicted that the values of compaction is 89% to 96%. Table 4 shows the results of sand compaction test results. The settlement plate of 12nos in the natural ground and the road space will be well performed for measured the settlement value at future.

4. CONCLUSIONS

Local sand is used to fill-up the low land of new acquisition land 16.352 acres of KUET under the project of "Expansion of Infrastructure and Academic Activities of Khulna University of Engineering and Technology (KUET)." The new acquisition land has been developed for enhancing the infrastructure of this university. There are one 10 storied Academic building Institute building and, 10 storied new student hall (male), lake and internal road way will be constructed in this land. The extended area of acquisition land was a low land used as fish cultivation pond. Total land of 16.352 acre and depth of 2.417m was filled by river sand name as local sand of Fines Modulus (FM) of 0.6 to 0.8 is used by the process of local method of water jetting with pipe network. 0.3m depth of soil layer are placed on filling sand in natural ground. Based on the study the following conclusion can be made:

(1) There are local materials bamboo, dram shit and geo-bags are used for site protection of outside of the new acquisition land and the side of lake which is economical and sustainable.
(2) The field compaction at the natural ground and road location and there values are about 95%.
(3) There are 12nos of settlement plate in the natural ground and the road space which be well performed as reference for measured the settlement value in future.
(4) It is depicted that this method of sand transportation is the cheapest method for carrying sand and time saving.
(5) This investigation revels that the land development use of local sand and available materials and the technique can be used as highly eco-friendly and environmentally method which may be used as suitable method to develop the low land for use space and construction of the infrastructures.

ACKNOWLEDGMENTS

This research was supported by the office of the Chief Engineer, KUET. Office of the Project Director, Expansion of Infrastructure and Academic Activities of Khulna University of Engineering and Technology" KUET and Construction Firm M/S Amir Engineering Ltd., Barisal. Special thanks to laboratory technician, Geotechnical Engineering Laboratory, Department of Civil Engineering, KUET for their assistance during working in the laboratory.

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